# NATURE

No. 4322 SATURDAY, AUGUST 30, 1952 Vol. 170


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*Editorial and Publishing Offices of "NATURE"*
MACMILLAN & CO., LTD.,
ST. MARTIN'S STREET, LONDON, W.C.2.
Telephone Number: Whitehall 8831. Telegrams: Phusis Lesquare London

Annual subscription £6, payable in advance, postage paid to any part of the world

*Advertisements only should be addressed to*
T. G. Scott & Son, Ltd., Talbot House, 9 Arundel Street, London, W.C.2
Telephone Number: Temple Bar 1942


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## NATIONAL PARKS AND LOCAL GOVERNMENT

IN the House of Commons debate on national parks and access to the countryside, held on July 14, Mr. Harold Macmillan, the Minister of Housing and Local Government, announced his agreement to the administration of the Snowdonia National Park for its first three critical years by three county committees with a joint advisory committee instead of the statutory joint board with its planning powers. The agreement was subject to six conditions, which included a fixed office and an independent planning officer; and, with the acceptance of these conditions by the three county councils concerned, only an appeal to the courts can now prevent this dubious decision taking effect. Mr. Macmillan in the debate made no attempt to justify his departure from the terms of the Act. His concession to local feeling does indeed appear to rest on a desire to secure an effective national park and on the recognition that the co-operation of the local authorities is essential if the national parks are to succeed, a recognition, however, which is fully shared by those who, like Mr. Anthony Greenwood and Mr. Blenkinsop, opposed his action.

Nobody, however, proposes, as Mr. Macmillan and Mr. Ernest Marples implied, to ride roughshod over the local interests. What the Minister and his Parliamentary Secretary seem to have overlooked is that it was largely the failure of local planning authorities to pay enough attention to the national interests that made the Act necessary. Opposition of the type displayed by the Merioneth, Caernarvonshire and Denbighshire County Councils was visualized as likely to lead to control of the national parks being taken completely out of the hands of the local authorities.

Moreover, while there is no reason to doubt the genuine desire of the three county councils concerned to establish a national park in Snowdonia, Mr. G. O. Roberts's speech in the debate shows why it is unwise, if indeed it is fair, to entrust policy or administration to local authorities. Where there is a clash between national and local interests, the local authorities are subject to an unfair tension; their financial resources are unequal to the task, and the major threats to national parks come from government departments and the large public authorities with which the local authorities are manifestly unable to contend on equal terms.

These are the critical issues, and they have been consistently passed over by the present Minister of Housing and Local Government and his Parliamentary Secretary as they were, on the Labour side, by Mr. Dalton and Mr. Blenkinsop. Moreover, in his speech on July 14 Mr. Macmillan advanced no satisfactory justification for ignoring the intention of the Act in this replacement of the joint planning board by a joint advisory committee.

Something much more fundamental than mere expediency is here at stake. It is already clear from the course of events since the National Parks Act was passed in 1949 that the populations—and certainly the

local authorities—of the districts chosen for the establishment of the national parks are indifferent, if not hostile, to the needs and desires of their urban neighbours and still more to the national considerations which led to the passing of the Act by Parliament. Both populations and local authorities have also shown a remarkable ignorance of the whole conception of a national park in Britain, and, to say the least, neither of the Ministers concerned have seemed prepared to give the National Parks Commission the resources to enable it to dispel ignorance which sometimes appears almost wilful. For evidence of this one need look no further than to the second report of the National Parks Commission or to some of the statements made before the public inquiry on the Minister's Order designating the North Yorkshire National Park. At that inquiry the Minister was urged both to delay confirmation of the Order for three years and to reduce the area from the 600,000 acres designated by the National Parks Commission to 250,000 acres.

Once again the representative of the National Parks Commission had to reiterate that designation of a national park did nothing to increase public access to farmland, and he pointed out further that the opposition of the Whitby, Thirsk and Hull water undertakings, the Blackfaced Sheep Breeders' Association and the Country Landowners' Association to the designation order was based on misapprehensions and misconceptions of the effects of designation which had been refuted at previous national park inquiries.

If opposition is frequently due to misconceptions and misunderstandings, it can be changed into co-operation when there is proper appreciation of the purpose and functions of a national park and the difference between it and ordinary county planning. That much is clear from the work of the Peak District National Park Planning Board. The few months experience of that body has convinced some of its members who were most opposed to a joint board, and anxious for an advisory committee instead, that a joint board can work effectively. The members of the Board have already shown their impartial outlook in considering industry and amenities, and are evidently growing out of a parochial idea of their responsibilities into one that is inspired by the conception of a national park which induced Parliament to pass the legislation.

Here there is evidence that a joint board can function and that its members recognize that success depends on the ability of its members to carry with them the authorities which they represent. Confidence that the joint advisory committee which Mr. Macmillan proposes for the Snowdonia National Park will, in fact, be guided, as he desires, by the National Parks Commission, will not be strengthened by the recent decision of the Dartmoor National Park Committee to sanction the erection of a television mast on North Hessary Tor. Both the Dartmoor Preservation Association and the National Parks Commission have asked the Committee to reconsider its decision, but without effect. In spite of this, neither Mr. Macmillan nor Mr. Marples in the debate on July 14 brought forward any evidence to justify their optimism over the surrender of national control.

It is clear enough, therefore, that if the co-operation and understanding of the local authorities, on which Mr. Marples, like his opponents, rightly lays such stress, is to be secured and, still more, if the financial support which he referred to as "quite indispensable" in addressing the annual meeting of the Sheffield and Peak District Branch of the Council for the Preservation of Rural England is to be obtained, a vigorous educational campaign must be undertaken as a matter of urgency. The gravest doubts as to the good faith of the Labour Party in this matter were roused by the actions of Mr. Dalton and Mr. Blenkinsop, and in using the adjournment debate on July 9 and the debate on July 14 to attack the Government on party lines. But Mr. Macmillan and Mr. Marples have need enough to establish their own sincerity and good faith, and it is to be hoped that in its next annual report the National Parks Commission will no longer have to complain that it is unable to conduct essential publicity campaigns for lack of the relatively small sum of £300.

The Minister will doubtless discount or ignore any attacks upon his policy made on party lines. He can scarcely overlook the fact, however, that members of his own party, and that doubts as to his intentions have been raised by his own actions in the minds of many responsible and independent people throughout the country. These doubts were not dispelled by his speech on July 14; and if any progress is to be made with the establishment of real national parks, some proof, rather than words, must be forthcoming to show that the Government is really concerned with the claims of amenity, of which Mr. Marples spoke so disparagingly. It should be noted, for example, that in its annual report this year the Council for the Preservation of Rural England reached the conclusion, from a review of various disputes with the authorities over electricity undertakings, and particularly the Malvern Hills case, that the tendency among government departments and local authorities to pay scant regard to the claims of amenity is increasing. Sir Patrick Abercrombie, too, has contended that despite consultation, public inquiries and departmental inquiries, these large impersonal organizations have become for all practical purposes above the law and outside the control of planning authorities.

That contention is completely endorsed by the Council for the Preservation of Rural England and is, as already indicated, one of the fundamental reasons for the concern with which Mr. Macmillan's departure from the administrative proposals of the National Parks Act is regarded. Instead of harping on the need for securing the co-operation and understanding of the local authorities, on the importance of which all are agreed, the Minister should first take positive action to assist the removal of misconceptions and misapprehensions, to the persistence of which the North Yorkshire Moors inquiry bore witness, and, second, inquire himself a little more closely into the reasons for such misapprehensions.

Two such causes have already been indicated: first, the slender resources which the National Parks Commission has at its disposal for publicity; and second, there is this question of control of departmental requirements—land needs of the Armed Services, mineral workings, water supply, electricity undertakings and others. Some independent means of assessing such requirements in relation to national needs as a whole is imperative. If we continue to allow departments to be judges in their own cause, neither nature reserves nor parks, national or local, nor even cricket fields are likely to survive in Great Britain.

But there is a third cause at which Mr. B. Keith-Lucas hinted in his recent book, "The English Local Government Franchise" (Blackwell, 27*s.* 6*d.*). The dispute over the administration of the national parks is a facet of the general problem of the relations between central and local government. For many years the powers and responsibilities, obligations and resources of local authorities have been getting out of alignment. To a large extent local authorities spend money which is not their own on policies which are not of their making. More and more local expenditure is fixed by forces outside the control of the individual authority, and this fixed expenditure tends steadily to increase, with consequent limitation of the area of initiative for the local authority. For example, half the gross expenditure of a large county borough may be on salaries and wages, in accordance with scales fixed by some independent body or by a national joint council.

While the local authority remains free, within limits, to reduce or increase its staff, it has largely lost the power to fix conditions of service, except in so far as it acts through some national negotiating body; in such circumstances it is understandable that local authorities should look askance at any proposals which would extend further the power of national standards to enforce a certain minimum expenditure on the local authorities. Mr. Keith-Lucas points out that extension of the system of joint boards proposed for the administration of national parks might well constitute a major threat to the independence of local government in Britain. Whether the system does, in fact, mark the beginning of a new form of central control of locally elected bodies cannot yet be seen. It is not clear, for example, whether the government nominees on such committees are free agents or whether they are expected to represent the ideas of the Government; but in the context of the general tendency for central control to go beyond what is justifiable either by present economic difficulties or by the financial aid given, the misgivings of some of the local authorities in this matter are understandable even if they cannot be condoned.

From this point of view it is equally clear that the prime responsibility for removing misunderstanding and opposition lies on the Government's shoulders. Government parsimony has not only impeded the removal of misapprehensions as to the nature of national parks, but has also accentuated the justifiable fears of the local authorities as to the effect on their financial resources. If there is to be a national policy, it must be implemented from national resources: the execution of such a policy should not depend on the ability of a particular local authority to supply the resources. If that were made clear, there would be less question of the willingness of local authorities to co-operate in working out a national policy which took full account of local interests as well as of the wider and long-term national and special interests, with which it is unreasonable to expect local authorities primarily to be concerned.

The abandonment of the Hobhouse principle that national parks should be nationally financed and administered was a mistake for which both political parties share the responsibility. The experience of the Peak District National Park Board, as already indicated, warrants the hope that collective exercise by such a Board of executive control over the whole of a park area may induce in its locally elected members a sense of independent and united purpose, of loyalty to the conception of a national park and of responsibility to the nation as a whole as well as to their own ratepayers. It is even possible to see here one of those fields for enterprise which are so important if local government is to retain vitality, and it should be noted that in a useful report on the scope for enterprise in local government, put out last year by the Research Panel of the National Association of Local Government Officers, some stress was laid on the importance of evolving new patterns of co-operation.

That report gave due weight to all those factors which we have suggested as helping to explain the attitude of local authorities to the national parks. In spite of these difficulties, however, and the limitation of experiment which central control and the economic situation place on even the counties and county boroughs, the report took an optimistic view of the scope for enterprise in local government. Particularly in the social services and in amenities, a vast sphere of work is still open to local authorities both in the technical development of services and in the development of systems of co-operation and administration.

National parks or nature reserves were not mentioned in this report; but the bearing of the conclusions of this report on the national parks question is unmistakable. If, however, local authorities are to respond to the challenge which is offered to them, a large measure of responsibility lies on the shoulders of the Minister of Housing and Local Government: he must no longer allow the educational activities of the National Parks Commission to be hamstrung for paltry sums; he should dispel such misgivings on the part of the local authorities as are directly due to the Ministry's refusal to provide the planning authorities of particular parks with the financial resources required for effective national planning; and he should terminate an appeasement policy which threatens to jettison the declared intentions of the Act in the face of misinformed opposition based on misconceptions for which the Ministry's policy is in part responsible.

Action in these matters will provide the best test of the Minister's belief in the idea of national parks and his desire for the efficient administration which he

has admitted is to be secured by a single authority such as a joint board. Mr. Macmillan has, moreover, indicated his acceptance of the principle that, in the areas designated as national parks, amenity is to be regarded as the overriding national interest; though the whole trend of his speech suggested that at the present time he attached rather a low importance to amenity as compared with other national interests. The danger is, of course, that irreparable damage may be done to amenity in the meantime if in some areas that interest is not supreme even at the present time.

For all that, there is evidence in Mr. Macmillan's speech of his ability to see the problem as a whole and to put the question of national parks in its proper perspective. It is his actions that have aroused doubts as to his intentions; but fortunately there is other and more reassuring evidence of his energy and initiative, such as his direction requiring all fresh applications for granting permission to extend or open quarries in the Peak District to be made to the Peak District National Park Planning Board in the first instance, and more particularly in that larger question of local government to which the question of national park administration is related. How close is that relation, and how large an opportunity for the invigoration of local government the wise administration of national parks by such devices as a joint board offers, are well brought out in a recently published study by Mr. D. N. Chester of the financial and administrative relations between central and local government. Two chapters, in particular, of this book—that in which Mr. Chester sets forth the assumptions on which his study is based and that in which his criticisms and proposals for improving such relations are detailed—deserve attention as much from the point of view of the administration of national parks as of the reform and reinvigoration of local government. They could well contribute to effect the closer co-operation and understanding, on the necessity of which in an effective national parks system all are agreed.

## HISTORY OF BOTANICAL EXPLORATION IN MALAYSIA

### Flora Malesiana

Being an Illustrated Systematic Account of the Malaysian Flora, including Keys for Determination, Diagnostic Descriptions, References to the Literature, Synonymy and Distribution, and Notes on the Ecology of its Wild and Commonly Cultivated Plants. (Published under the auspices of the Botanic Gardens of Indonesia, Bogor, and of the Rijksherbarium, Leyden.) General Editor: Dr. C. G. G. J. van Steenis. Series 1: Spermatophyta, Vol. 1: Malaysian Plant Collectors and Collections; being a Cyclopædia of Botanical Exploration in Malaysia, and a Guide to the Concerned Literature up to the Year 1950. By Mrs. M. J. van Steenis-Kruseman. Pp. clii+639. (Djakarta and Groningen: Noordhoff-Kolff N.V., 1950.) 55.50 fl.

THE "Flora Malesiana" now in progress of publication is a magnificent effort designed to give a detailed and systematic account of the botany and vegetation of 'Malaysia', including the Malay Peninsula, Indonesia, the Philippine Islands, British Borneo, Portuguese Timor and New Guinea. It will, we are told, be preceded by three volumes of a general character, of which the present one is the first to be published. This volume has been written by Mrs. M. J. van Steenis-Kruseman and has as a separate title, "Malaysian Plant Collectors and Collections; being a Cyclopædia of Botanical Exploration in Malaysia, and a Guide to the Concerned Literature up to the Year 1950". It is evident that much bibliographical and biographical research, spread over a period of approximately twelve years and involving the immense task of consulting a world-wide literature on the subject, has gone into the preparation of this volume. The result has been the building-up of a fully comprehensive and informative work, the most complete contribution to our knowledge of the history of botanical exploration in Malaysia ever published.

The introduction to the volume, forming Chapter 1, covers more than thirty pages and outlines the aim and history of the work and its purpose as part of the "Flora Malesiana". It goes on to deal with private collections of Malaysian plants, gives copious notes on mislabelled botanical collections, and includes an annotated list of the literature for the use of explorers, ending with an account of the etymology of vernacular names for the plants. All those who intend to collect in the tropics will find the directions contained in the chapter on the technique of plant-collecting invaluable. The dangers encountered, the equipment needed, what and how to collect, the dispatch of living plants, and many other matters are described in a full and detailed manner. Indeed, the information will doubtless be found useful to many people other than botanists, and the wide field covered by the volume should result in a demand for it by those with interests in the history of other branches of science such as zoology, etymology, agriculture, horticulture, medicine, forestry, ethnography, geography and so on.

In Chapter 3 the delimitation of Malaysia and its main geographical divisions are dealt with and include unpublished data, while diagrams and figures are given to illustrate distribution. Attention is paid to the inner divisions of the flora, and the theories and arguments of Earle, Sal. Müller, Zollinger, Miquel, Wallace, Merrill, Malm and Dickerson are discussed. Reference to the collections is made in the next chapter, which gives a complete list of the voyages and expeditions in chronological order and also provides a useful geographical survey. Desiderata for future exploration are next considered, and attention is given to the work of future botanical collecting. Another chapter contains references to important sources of information used in compiling the list of collectors and also includes other information relating to herbaria where collections of Malaysian plants are to be found. There are also seventy specimens of facsimile handwriting of well-known botanists, which will no doubt be found extremely useful in identifying handwriting on herbarium sheets.

The rest of the volume, consisting of 639 pages, is devoted to a very valuable cyclopædia of collectors. This contains brief biographical sketches of some three thousand people who have been concerned at some time or other with the botany of Malaysia. Itineraries, collecting localities, collections and literature follow the sketches, and many portraits are included. Here many celebrated men are dealt with,

such as Solander, Banks, Thunberg, Commerson, Cook, Korthals, Koorders and so on. In many cases, no biographies have hitherto been available or were only to be found in special or obscure publications. The book ends with a select index which has evidently been carefully compiled.

One can have nothing but praise for this book, which is a veritable mine of information. To all botanists interested in or visiting Malaysia it will be quite indispensable. H. S. MARSHALL

## CONTROL OF PUBLIC EXPENDITURE IN BRITAIN

### The Control of Public Expenditure

Financial Committees of the House of Commons. By Basil Chubb. Pp. viii+292. (Oxford: Clarendon Press; London: Oxford University Press, 1952.) 25*s*. net.

DR. BASIL CHUBB'S scholarly survey of the financial committees of the House of Commons is concerned not, as the original Public Accounts Committee, with unauthorized spending, but with wise spending—the most efficient use of public money. Nor are controls of the type which are here considered a substitute for efficient administration. That is the first and indispensable safeguard, and the system of control which Dr. Chubb reviews in this book might be described essentially as one of obtaining *prima facie* evidence that administration is in fact sound. This study shows what care has been taken to avoid infringing departmental responsibility and to secure the co-operation of the departments in providing the information essential for the formation of a balanced opinion upon their activities.

Such co-operation and the provision of adequate information are the essential conditions for independent control of this type. There are others which Dr. Chubb also puts forward as necessary if a Select Committee is to examine expenditure effectively: practicable and clear-cut terms of reference; an appropriate organization; means of ensuring that notice is taken of its recommendations; and liaison and co-ordination arrangements with the Public Accounts Committee. Given these, and there is no reason why the essentially amateur character of such a Select Committee's inquiries, in contrast to the more professional probing of accounts by the Public Accounts Committee, with the expert assistance and guidance of the Comptroller and Auditor General and the Audit Department, should not yield extremely useful results. Even such a complicated and technical question as the national organization for scientific and industrial research has been usefully probed in this way, as the third report of the Estimates Committee for the session 1946–47 shows.

The work of the Estimates Committee and of the Public Accounts Committee appears, in fact, already to have shown the lines along which control is to be effected. The task confronting us to-day is to determine exactly what new type of information is required regarding such bodies as the University Grants Committee and the Department of Scientific and Industrial Research for an accurate appreciation of the efficient performance of their services and the wisdom of their expenditure. With this there may also be required, indeed, something more than a financial scrutiny—a scrutiny of method, based on the investigation of departmental practice and organization. Largely this will be a matter of departmental administration, though in part it may be stimulated by the inquiries and activities of the Select Committee.

How far any really radical change in this respect is necessary cannot easily be judged from Dr. Chubb's review. Seldom, if at all, does he indicate the outcome of the recommendations of the Select Committee on Estimates, and we are given no means of judging whether or not there exist at present adequate means of ensuring that notice is taken of the recommendations of the Estimates Committee. This, however, is vital if the work of the Committee is not to be in vain, and public control is to be a reality and not a sham.

Dr. Chubb's book gives a clear historical account of the development of a system that has already served us well. His book is also to be welcomed as a pointer to the directions in which fresh thought and study are required if we are to adapt the system to serve still more closely the conditions of to-day, and particularly to solve such problems as those of the control or investigation of the great public corporations and of the formation of an educated public opinion which is not only satisfied that money is wisely spent, but also understands the relation of such expenditures to national welfare clearly enough to be immune from hysteria at a time of economy. Such problems involve scientific study by some at least of the Departments of State: they equally involve co-operation and hard thinking among scientific workers and technologists, as well as administrators, by whom and on whom some of these large sums will be spent. R. BRIGHTMAN

## CLAY MINERALS

### X-Ray Identification and Crystal Structures of Clay Minerals

Edited by G. W. Brindley. Pp. vii+345. (London: Mineralogical Society, British Museum (Natural History), 1951.) 35*s*.

THIS is an indispensable reference work for the scientific workers who are trying to bridge the gap between the well-crystallized minerals and those fine-grained and generally less well-ordered ones generically termed clays. Clay was one of the first raw materials to be used by man, and the numerous and sometimes beautiful surviving achievements of early potters in many lands testify to the extensive deposits of useful clay that have been discovered in the past. In Great Britain we have been fortunate in possessing good deposits of kaolinite and of fuller's earth (montmorillonite) that have been known and widely used for centuries. The foundation of the Clay Group of the Mineralogical Society of Great Britain in 1947 indicates a resurgence of interest of scientific men and women in clay and a welcome *rapprochement* of workers from industrial, university, government and other laboratories.

The monograph now under review is the first of its kind to appear in Britain and is a tribute to the inspiration and industry of the editor and his team of French, American and British experts who have given so generously of their time to the collection and dissemination of useful knowledge. Identification is an essential preliminary to all crystallographic studies. X-ray diffraction has proved to be the most

powerful method of identifying clay minerals, and due acknowledgments are made to the Bragg school, Ross and Kerr, Pauling, Hendricks and Nagelschmidt for their pioneer work. The value of auxiliary techniques is emphasized, and well-balanced accounts are included of chemical, optical and thermal studies. Mechanical analysis, aided by the centrifuge, is a necessary prelude to the application of X-ray diffraction, chemical and thermal techniques to the quantitative study of clay, soil and ocean deposits. Chapters of a more advanced nature describe crystal structure studies of montmorillonite, halloysite, fireclay and chamosite, and X-ray studies of interstratified and disordered layer lattice minerals. A knowledge of the silicon–aluminium oxygen layer framework and where the layers of water molecules are located can often be extended to a more detailed account of where additional elements—potassium, sodium, magnesium, iron, etc.—are also situated. Thus are explained many of the known properties of clay minerals. It is not too much to expect that more exact crystal structure analyses will lead to the prediction of unsuspected properties, some of which may be useful to science, art and industry.

F. A. Bannister

## CHEMISTRY OF LIGNIN AND WOOD

### The Chemistry of Lignin

By Friedrich Emil Brauns. Pp. xv+808. (New York: Academic Press, Inc., 1952.) 14.50 dollars.

### Chemistry of Wood

By Erik Hägglund. Pp. x+631. (New York: Academic Press, Inc., 1951.) 13.50 dollars.

THESE two books have much in common. Each has as author a prominent member of a pulp and paper research organization—Brauns being of the Institute of Paper Chemistry, Wisconsin, and Hägglund of the Swedish Forest Products Research Laboratory—and both authors are prominent authorities on the subject-matter covered. Both books, too, are essentially documentary in character and contain some 2,200 and 1,400 references to the original literature, respectively. Peculiarly enough, the same (and indeed, only) adverse comment applies to both — namely, that they are, if anything, too documentary and perhaps insufficiently critical of the work recorded, including the author's own.

The chemistry of lignin is in effect largely the chemistry of wood, so that overlaps are to be expected and indeed make comparison a matter of some interest. For example, sections on the structure of lignin and its formation and role in the plant are common to the two volumes. Both books adopt an essentially chemical approach to their subject, although the wider industrial implications are duly recognized, even if they are not fully discussed as such. Thus, Brauns emphasizes how the academic chemical approach to the problem of lignin structure via its chemical reactions should lead to the solution of that major problem of all pulping industries, namely, the economic utilization of lignin instead of its disposal as a highly objectionable effluent. Similarly, Hägglund's book has chapters on the chemistry of the acid and alkaline pulping processes used for the manufacture of wood pulp for paper and rayon manufacture.

As might be expected, Brauns's book is the more restricted in scope although, in consequence, each section is correspondingly more detailed. Aspects covered are the analysis of lignin, its isolation, and its physical, biological and chemical properties and reactions, together with its role and formation in the plant. A long chapter deals, of course, with the various theories of the structure of lignin. Unfortunately, it leads to the conclusion that it is premature to suggest a constitutional formula for lignin, although there is strong evidence that lignin is a high polymer comprising at least 75 per cent of phenylpropane 'building stones'. The structure of these 'building stones' and the mode of their combination are, however, still unknown, and indeed Brauns regards our knowledge of the structure of lignin as comparable with that of cellulose more than a hundred years ago.

Hägglund's book is a revised edition of "Holzchemie", first published in 1928 (second German edition, 1939), now, significantly enough, appearing in English although printed in Sweden and published in the United States. The ground covered includes wood tissue and formation, the physical and chemical properties of wood and its various constituents, the chemistry of wood saccharification (Rheinau process), and the sulphite and alkaline pulping methods and associated bleaching processes. The carbonization, caustic fusion, storage and natural decomposition of wood are also dealt with.

It is noteworthy, and a tribute to both the authors and publishers, that although the books are printed in Vienna and Sweden, respectively, the standard of production bears very favourable comparison with the best of similar books published in Great Britain. These two books, though similar, can be highly recommended as full, authoritative and up-to-date accounts of our present knowledge of wood and its constituents. On the whole, they are complementary to, rather than substitutes for, one another; and studied together they should meet every need of all workers on the subjects of wood and lignin.

Julius Grant

## ABSTRACTING FOR PHYSICISTS AND ELECTRICAL ENGINEERS

### Physics Abstracts

Section A of Science Abstracts. Vol. 54, 1951. Pp. vii+1460.

### Electrical Engineering Abstracts

Section B of Science Abstracts. Vol. 54, 1951. Pp. xii+737.

(London: Institution of Electrical Engineers, 1951.) £2 10*s*. each section; £4 10*s*. both sections.

IN 1948 the Royal Society Scientific Information Conference in London discussed among other topics the question of improvement of abstracting services; in 1949 Unesco convened a conference in Paris to discuss the co-ordination of the various science abstract journals, and in 1950 the results of an extensive and detailed study, undertaken by the American Institute of Physics with the financial assistance of the U.S. Office of Naval Research, of the opinions of physicists on *Physics Abstracts* (*Science Abstracts A*) were published (*Amer. J. Phys.*, 18, 417; October 1950. See also *Physics Today*, 4, 18; August 1951). The principal object of the latter inquiry was to ascertain for what purposes physicists use abstracts, their opinion of the abstracting services

available to them and what, within reason, they would like to have in the way of physics abstracting. The result showed that physicists regarded "wide coverage of periodicals" as the primary requirement. "Prompt publication of abstracts", "abstracts written by subject experts" and "extensive indexing" were considered of equal importance but a very poor secondary requirement. Recommendations to implement these requirements were submitted to the management committee of *Physics Abstracts* and were readily accepted. Indeed, it stands to the credit of the editor (Dr. B. M. Crowther) and the committee that nearly all the suggested improvements had been anticipated and in many cases put into effect before the results of the above inquiry were made public. Subscribers to *Science Abstracts* will have noted with satisfaction the considerable expansion and gradual improvement generally of both *Physics Abstracts* and *Electrical Engineering Abstracts* (*Science Abstracts B*) during the past few years.

Commenced in 1898 when it was the first journal of its kind, *Science Abstracts* is now the major abstracting journal covering articles with a physical interest in mathematics, astronomy, astrophysics, geodesy, physics, physical chemistry, crystallography, geophysics, biology, technical materials and photography in Section A, and articles of interest to electrical engineers in engineering, electrical engineering, electronics, telecommunication and technology in Section B. The journal is controlled by a management committee consisting of council members of the Institution of Electrical Engineers, the Physical Society, the Royal Society, the British Electrical Authority and an observer from the American Physical Society. The executive officers are the Secretary of the Institution and the Editor of *Science Abstracts*. Facilities and administration are provided by the Institution; but the financial responsibility is borne jointly by the Institution and the Physical Society. The circulation of Section A is very large, greater than 12,000. Until quite recently more than half the number of copies sold were purchased by the American Physical Society for distribution to its members automatically as a privilege of membership and without extra cost; every member of the Physical Society receives a copy; a copy for personal use may be purchased at a considerably reduced rate by members of the Institute of Physics and members of the Institution; and a large number of copies are sold to the general public, mainly libraries and organizations. Though Section B, with a circulation of 4,000, has not such a wide appeal as Section A, its circulation is still quite good. It could, however, be improved among physicists, for more than half the copies issued are distributed to members of the Institution and a large part of the remainder sold to libraries and organizations.

The price of *Science Abstracts* is remarkably low, and although it has had to be raised recently, the increase is by no means in proportion to the expansion in the journals which has taken place since 1945. For example, the 1951 volumes (*A* and *B*) contained 9,908 (1160 pages) and 4,650 (624 pages) abstracts respectively and indexes covering approximately 300 and 100 pages respectively, whereas in 1945 the corresponding figures were 3,148 (339 pages), 2,744 (292 pages) and indexes of approximately 60 and 50 pages respectively.

The corresponding increase in price, however, has been only about 50 per cent. Furthermore, the time-interval between the appearance of an article and the publication of the abstract in *Science Abstracts* has been reduced considerably. The speedy publication of the annual indexes is most important, and before the Second World War the annual indexes appeared regularly in February. For many years since, however, this was not possible and when, therefore, in 1950 the pre-war practice was resumed many people doubted whether it could be maintained. However, they were to receive a pleasant surprise, for the annual indexes for 1951 were distributed to subscribers in mid-January 1952, a feat of which the editor and his staff must feel justly proud.

It is difficult to review Vol. 54 of Sections A and B without making a few comments and suggestions, though admittedly these are of minor importance and are naturally the reviewer's own personal views. It is irritating to find only a supplement to the list of journals abstracted at the beginning of Vol. 54 and to have to refer to an earlier volume for the main list. Books, in addition to articles in scientific journals, are sometimes abstracted, but it is difficult to ascertain on what basis these books are selected, and in any event how does one abstract a book? The varied styles of the book abstracts reveal some of the difficulties the abstractors have had in this regard, whether to go to the one extreme of a review or the other extreme of a mere copy of the contents list. There are still too many abstracts in which the title of the article is repeated as the opening sentence, though this fault is more or less confined to author abstracts. The onus here is really on the editor of the journal in which the article abstracted appeared; but it perhaps would be a good thing if *Science Abstracts* were ruthless in revising such abstracts. Referees of scientific papers should be encouraged to comment on the abstracts as well as on the contents of the papers submitted to them.

The remarkably few misprints, the clear type and lay-out of the abstracts, the detailed author and subject indexes and the ease with which one can find one's way about the abstracts, in addition to the consistently high standard of the abstracts and arrangement, are praiseworthy features. The Universal Decimal Classification system of classification is excellent for arrangement, but it is doubtful whether the time and labour involved in printing the U.D.C. numbers is worth while. Complete coverage of all periodicals is, however desirable, obviously impracticable, and the close co-operation between the various abstracting journals to make use of each others' abstracts is to be encouraged. *Science Abstracts* now includes many abstracts prepared by other abstracting journals.

In accord with recommendations of the Royal Society the abstracts are "written concisely and in normal rather than abbreviated English", but abbreviations of words are used and in some cases these may not be familiar to the reader; for example, a physicist may not recognize that 'o.h.' stands for 'over-head'. So far as possible, abstracts should be easily read and should be self-explanatory, so that abbreviated words (except, of course, recognized units) should be avoided. There remains but one last comment and plea. If the editor of *Science Abstracts* sees fit to increase still further the number of abstracts a year in *Physics Abstracts*, he is asked to bear in mind that *Abstracts A* is now as large as can be conveniently bound in one volume and that if it were bound in two separate parts, though naturally more costly, it would be easier to handle, and the binding would not be so highly strained. S. WEINTROUB

# SCIENTIFIC THOUGHT THROUGH THE AGES*

By Dr. NAZIR AHMAD
Chairman, Pakistan Tariff Commission

THE rudiments of scientific thought must have started as soon as man began to think for himself. When he saw the natural phenomena with which he was surrounded, the rising and setting of the sun, the phases of the moon, the twinkling of the stars, the rain, the wind, the lightning, the change of the seasons, the growth of plants and crops, he must have begun to wonder about their causes; and that wonder was the starting point of the scientific thought in him—the seed from which the tree of knowledge was ultimately to grow. In the distant past, man tried to reproduce natural phenomena by imitating Nature. He conceived the idea that if he imitated any aspect of Nature, he would be able to reproduce it. For example, he associated the croaking of frogs with the oncoming of rains; and he concluded that, if he imitated the frogs, he might bring down rain on earth. There are numerous instances of such imitation on the part of early man with the object of reproducing natural phenomena, which have come down to us in the form of dances and rituals. This attempt on his part to reproduce natural phenomena by imitation led to what is now called 'imitative magic'. This form of magic, associated with what is known as 'contagious magic', was man's earliest attempt, in a crude way, to comprehend and explain some of the natural phenomena. However, whether it was 'imitative magic' or 'contagious magic', it was slowly transformed either into scientific thought, when an effort was made at a rational explanation, or into a religious belief, when natural phenomena were explained in terms of deities, gods and goddesses or a supreme being. According to one school of anthropologists, magical conceptions led to religious beliefs on one hand, and scientific thought on the other; while a second school of anthropologists holds the view that the transition was from magic to religion and from religion to science. Be that as it may, this intermingling of magical concepts and religious beliefs with scientific thought, which started right in the beginning, remained one of the dominant features for many centuries; and was, and perhaps still is, responsible for the slow victory of rational thought over superstition and out-moded belief.

Coming to the development of scientific thought, as we understand it to-day, we find its rudiments in the civilization of Babylon, where their mathematicians developed a mixture of the duodecimal and decimal systems—from the ten fingers and two hands; and, because the number 60 was the first common multiple of 10 and 12, it acquired a special significance, which it has managed to preserve even to the present time. It is from there, indeed, that we get divisions like 60 seconds to a minute, 60 minutes to an hour, 60 seconds to a minute in the measurement of an angle, etc. With this useful discovery of the rudiments of arithmetic, magical ideas got strangely inter-woven; this retarded the progress of scientific thought, especially when the Chaldean astrologers acquired the upper hand. Apart from this discovery, the Babylonians were the first to undertake the cultivation of cereals; this compelled them to devise some kind of a calendar, which is one of the earliest in the world. From their astronomical observations, they were able also to calculate the relative positions of the sun and the moon, and predict solar and lunar eclipses; but, instead of pushing forward the bright science of astronomy, they turned aside into the dark regions of astrology, and evolved a curious conglomeration of both.

From Babylon the scientific development passes on to Egypt, where we find the first use, on a large scale, of the wheel as a scientific tool. Great strides were made in the science of land measurement, because when the River Nile, which is the life-line of the Egyptian cultivators, was flooded, the fields and the farms got terribly mixed up; and the Egyptians found that the science of land measurement was necessary to enable them to know to whom a particular plot of land belonged. Apart from these advances, other great advances, for which the old Egyptians were responsible, were in the fields of physiology and surgery, which resulted from their art of mummification. They, for the first time, performed fairly complex surgical operations, and discovered certain physiological principles. Contemporary with the civilization of ancient Babylon and Egypt was the civilization of India, where memorable advance was made in the theory of numbers; in fact, where for the first time the numerals one to ten, as we know them, were used extensively, which later on were taken by Arabs from India and passed on to Europe, and hence they came to be known as Arabic numerals. In India, the science of medicine also made fair progress—especially under the influence of the Buddhistic teachings, which laid great emphasis upon love, fellow-feeling and sympathy. But the advancement of science and the progress of scientific thought in India were retarded by the conflict with such philosophical concepts as the transitoriness of earthly existence and the evanescence of life. The Indian philosophers were more concerned with the life hereafter, and they regarded life on this earth as *maya*, a shadow, a fleeting moment, which did not deserve serious consideration.

Such was the intellectual background of the civilizations of ancient Babylon, Egypt and India, until the blossoming of scientific thought, as we understand it, took place in Greece about the fifth century B.C. The ancient Greeks revealed themselves as amazing people with an unquenchable thirst for truth; and the freedom of thought witnessed among them had not been equalled anywhere before their time. Indeed, their freedom of thought was so unfettered that their great dramatists wrote satires and comedies on subjects which the common people venerated; and these were actually produced on the stage. This freedom of thought among the ancient Greeks was one of the motivating forces for their great scientific and philosophical advance. Pythagoras was the first philosopher who developed the abstract idea of numbers, which he probably took from the ancient Indians, as he was acquainted, to some extent, with their philosophy. He was also responsible for the concept of four primary elements

* Substance of a public lecture given before the Fourth Pakistan Science Congress at Peshawar on March 17.

which constituted the basic materials for all the other countless objects of this world; these four elements being earth, water, air and fire. The Greeks were the first people who paid serious attention to the problem of matter; and tried to find out whether the great variety of objects, which constitute the material world, could be explained in terms of a single element. They were not successful in this synthesis because their efforts were more flights of imagination than scientific theories based upon solid data. However, in this process, a group of philosophers, known as Atomists, rose among them, who, by a wonderful insight, were the first people to express the idea that matter is ultimately made up of small particles, which they called 'atoms'. The philosopher who gave the final touches to this hypothesis was Democritus, and his exposition has been handed down to us in a fine poem by Lucretius. However, the hypothesis was not supported by any experimental facts, as was the case with Dalton's hypothesis many centuries later; and therefore, when it was attacked by other philosophers, like Plato and Aristotle, it could not withstand their criticism.

Nevertheless, the philosophical inquiries, which were begun by the early Ionians, were pushed forward until we come to Socrates who, for the first time, began to question openly and relentlessly beliefs and ideas commonly held by his contemporaries. He did not originate any system of philosophy; but he was the founder of what is called the Socratic system by which beliefs, notions and views commonly held by people are analysed and cross-examined until one begins to see the fallacies underlying them, and thus the ground is prepared for building a more stable structure. His work was carried a step forward by his great pupil, Plato, who, however, denied reality to individual objects, and put forward the view that objects, as we see them, are unreal because they are continually changing; while reality lies in abstract 'types', of which the visible objects are mere shadows. Because of his emphasis on 'reality' in certain 'ideal' types, Plato's philosophy is sometimes known as Realism and sometimes as Idealism. This philosophy actually proved a setback to the development of scientific thought, because it took man's attention from nearby objects on earth, and riveted it upon abstract and ideal types, which existed only in imagination.

Reaction against Plato's philosophy occurred soon in the teachings of his famous pupil Aristotle, who put forward the idea of dual reality, according to which a certain measure of reality attached itself to the individual objects, though the thoughts and ideas which the human mind perceived from those objects were also equally real. This dualism in reality, which Aristotle postulated, helped to bring back men's minds to the objects of this earth for scientific study; and it persisted in the philosophical field, in one form or another, for centuries until it blossomed forth in the teachings of Immanuel Kant. However, Aristotle's great achievements were not in the fields of physics, mathematics or astronomy, in which he held rather fantastic notions, but rather in the fields of medicine and deductive geometry, in which he made notable contributions. His success in deductive geometry led him to found deductive logic, in which one argued from general principles to particular cases. The deductive logic, which really represents half the picture, was, to Aristotle's mind, almost the complete logic; and he applied it vigorously to the explanation of natural phenomena, with the result that he was responsible for several fallacies, which, under the weight of his authority, persisted for many centuries. He was also responsible for the rejection of the atomic theory, as propounded by the early Greek Atomists; and he went back to the ideas of the Pythagorean school that all matter is ultimately made from four primary elements. However, he went a step further, and instead of defining the so-called elements in terms of earth, air, water and fire, he defined them in terms of four primary qualities, namely, hot, cold, wet and dry. He developed the theory that these four cardinal qualities, in their various combinations in different quantities, were responsible for the numerous objects which we see around us. Some reaction against Aristotle's philosophy was set in motion by Epicurus, who taught that 'reality' is essentially sensation and sense-perception, and thus tried to turn man's attention to the study of objects as one became aware of them with one's senses; but unfortunately the finer aspects of his philosophy were submerged in a baser interpretation, and the theory failed to achieve its objective.

As against these great philosophers, who freely mixed scientific thought with philosophical notions and scientific observation with flights of fancy, we have the brilliant example of a true scientist—Archimedes—who did not begin with any preconceived philosophical notions, but approached Nature from the point of view of an experimental scientist. He was the founder of the science of mechanics, the discoverer of the principle of the lever, the designer of engines of war which kept a numerically superior army at bay; and in his various researches he showed the scientific spirit by going cautiously from step to step and proving the validity of every step he undertook. The ancient world holds few examples of such marvellous combination of the qualities of imagination, deduction and verification as shown by Archimedes, who fell under a Roman sword.

After Archimedes the study of science shifted mostly to the famous school of Alexandria, which contained well-organized sections devoted to the advancement of biology, physics, chemistry, mathematics, etc. But the greatest strides in this school were made in astronomy; and it was there that for the first time the old notions about the movements of the earth and the heavenly bodies were examined, and a working theory known as the Ptolemaic system, in which the earth was made the centre of the universe, was put before the world. In spite of its obvious drawbacks and complicated explanations, this theory held the field for several centuries for two reasons. In the first place, it made man and his abode the centre of the universe, which greatly pleased his vanity. Secondly, it was considered to be in accord with the teachings of the Scriptures, and in fact enjoyed the blessings of the Christian Church. We have here another example of the way in which a scientific theory can get mixed up with personal considerations and religious conceptions, and derive its strength not from scientific data but from the backing which an extraneous agency can give to it.

After the rise of the Roman Empire, the service of science naturally passed on to the Romans; but one has to confess that very little advance was made by them in the fundamental sciences. They were a practical people, and they concentrated on applied science, such as agriculture, engineering and irrigation,

while neglecting in general the study of pure science. A notable exception, however, was the famous physician Galen, who, though of Greek origin, flourished in Roman times, and who made substantial contributions to the sciences of physiology and medicine.

The fall of the Roman Empire was followed by a long period of decline of learning in Europe, attributed generally to the hostility which the organized Church offered to the Greek learning handed down to the people. According to the teachings of the Church at that time, the ultimate 'reality' was spirit and the ultimate values were spiritual; and, therefore, any study which took away people's minds from spiritual values and the ultimate 'reality', namely, the spirit, was to be eschewed. As a result of this attitude, the so-called Dark Age descended upon Europe and lasted for nearly four hundred years. At this time the torch of learning was, however, grasped by the Arabs, and it was kept aloft by them, burning brightly. The first task of the Arabs, when they took over the service of science, was to re-discover the hidden treasures of Greek learning. They translated the books of Greek philosophers and scientists, Plato, Aristotle, Galen, Hippocrates and others, and wrote commentaries upon them. But that was not all. They went far beyond it. They made very considerable progress in almost all the different branches of science. In chemistry, led by the motive of discovering the elixir of life, they made great strides. Their knowledge of the human body and the functions of its various organs excelled the past, and they went far ahead of the Greeks in medicine. In mathematics, they founded a new branch known as algebra. In physics, especially in optics, they made very remarkable original contributions. They made accurate charts of the heavens, and navigated the seas as had never been done before. But in spite of these original contributions to different sciences, the underlying scientific thought remained largely Aristotelian. Deductive logic held the field, and the Arab scientists and philosophers had only a vague conception of the principles of inductive logic; so that, like the Greeks, they also argued from the general to the particular. They accepted many Grecian fallacies, and did not bother to perform experiments to verify them. In one essential respect, however, Arab thought differed fundamentally from the Greek point of view. The Greek conception of the universe was more static than dynamic; they were inclined to regard the universe as a complete entity in which no fundamental change was possible. Many of the Arab philosophers, on the other hand, took a dynamic view of the universe, which, according to them, was constantly undergoing change and development, even by a process of trial and error.

Among the many Arab philosophers who made a real contribution to scientific thought the name of Ibn-i-Rushd, known in Europe as Averroes, stands out prominently for a remarkable thesis on the relationship between religion and philosophy. He stated that religion was essentially a personal experience, which could not be demonstrated; while science, on the other hand, was knowledge the results of which could be demonstrated by one man to another. He further pointed out that theology was a mixture of religion and science, and as such a source of evil to both, because it corrupted religion with pseudo-science and imposed fallacious notions on science in the name of religion. It is a great pity that this profound lesson, which was taught by Ibn-i-Rushd nearly a thousand years ago, has not been fully appreciated by later thinkers, especially in Islamic countries, where the tendency to superimpose one branch of knowledge upon the other persists to the detriment of both. Another thinker who exercised a great influence on the development of scientific thought in the Muslim world was Ghazali, who was considered a master of learning in his time. He was originally a professor of philosophy in the Nizamia University, but when he saw the shortcomings of the Aristotelian deductive logic, he became disgusted with it; and without realizing that the Aristotelian logic, as inherited by the Arabs, was incomplete and, therefore, unable to explain all or even most of the phenomena, he turned his face away from it, and launched a vigorous attack upon philosophy and science in general. His forceful personality and wide learning carried great weight with his contemporaries; and his attack upon philosophy is regarded by some people as the beginning of the decline of philosophical and scientific studies in the Muslim world. In any event, the pendulum swung in the other direction, and in the thirteenth century the pursuit of learning and development of scientific thought passed again to the Western countries.

This revival of learning in Europe at this time took a curious shape. The hold of the Church on the people was still very strong, and full freedom of thought and expression was not permitted. But, as the writings of the Greek philosophers, especially of Aristotle, and the contributions of Arab philosophers were studied, it was found that they contained many ideas and notions which went against current thoughts and beliefs. As these contradictions between the two accepted authorities created intellectual conflicts, St. Thomas Aquinas tried to harmonize the religious concepts of the time with the postulates of Greek learning as handed down to Europe by the Arabs. This notable attempt at reconciliation of religious concepts with philosophical ideas, called Scholasticism, held the ground for more than two centuries. Such attempts are not peculiar to Europe; they have been made in other countries as well. In the history of Islam, similar attempts were first made by the M'otazalin in the early days of the Abbasid Caliphate, later by the Mutakallimin, still later by Ibn-i-Tameea and his disciples, and even in our own time it is being made by many people.

However, in Europe, there were a few thinkers who saw that this attempt at the synthesis of religious beliefs with scientific thought was not always successful. Notable among them was Roger Bacon, who was one of the first to realize the ineffectiveness of this approach. According to him the four great obstacles to learning were: (1) regard for authority; (2) force of habit; (3) prejudice; and (4) false conceit of knowledge. It is really remarkable that a man, who lived nearly seven hundred years ago, was able to put his finger precisely on the principal causes which can hold back the advance of learning in any age. Due to the writings of men like Roger Bacon and others who followed him, Scholasticism gradually declined in Europe, and gave birth to the Renaissance in the fifteenth century. A great deal has been written upon the revival of learning in Europe, in which science ultimately comes into its own, and parts company, on one hand, with philosophy and, on the other, with religion. But we must not forget that, apart from the intellectual activity, which was going on at that time, there were certain material factors which helped considerably the Renaissance

movement in Europe. These were, first, the use of paper, originally invented in China, which made learning more accessible to the masses. Secondly, there occurred at that time the invention of printing, reducing greatly the laborious art of writing books by hand, which could thus reach thousands instead of hundreds of people. Perhaps even more important than these two factors was the development of the science of navigation, in which the Arabs had made great progress and which was learnt from them first by the Portuguese and the Spaniards, who happened to come in greater contact with them. The development of navigation opened up new lands to European nations, which not only stimulated their imagination but also increased their power and material prosperity. The judicious investment of surpluses enabled them to make still larger profits, and the wealth thus earned gave a tremendous impetus to the expansion of trade and industry.

As a result of the intellectual activity of men like Roger Bacon, assisted by the impact of physical forces like the invention of printing, and the accelerated means of communication and contact, Europe produced a number of thinkers who can be regarded as the precursors of modern scientific thought. One of the first great figures among them is Leonardo da Vinci, who although not responsible for any great scientific discovery himself was yet able to demolish a large number of fallacies by approaching each subject with an open mind. His approach to any difficult subject was generally from the practical side. When he formulated a theory, he first tried to test it by making models. He made models of tanks, aeroplanes, and even submarines. These, of course, were unworkable, because his knowledge of detail was insufficient; but they go to show his eminently practical approach, so essential to scientific progress. We then have Copernicus, who studied the planetary motions carefully, and found that the geocentric theory of Ptolemy was not able to explain these motions so easily and elegantly as the heliocentric theory. This discovery was a great blow not only to ancient learning, but also to the attempts made to harmonize scientific thought with religious beliefs. About the same time came Harvey, who discovered the circulation of the blood, and, thereby, upset another great fallacy—the fallacy of 'humours'—which had prevailed among men of science since the time of the Greeks. The same period saw Gilbert, the father of magnetism, who by his researches helped the further development of navigation, and who gave us new ideas regarding terrestrial magnetism.

Along with these experimental scientists, who went on demolishing one fallacy after another with their discoveries, we have Francis Bacon, who formulated clearly the principles of inductive logic. In his writings he stated that the task of a philosopher is the collection of facts, the formation of a hypothesis, and the verification of the hypothesis by further experimentation and observation. For the first time the principles of inductive logic were clearly stated; and as if to show that the hour was ripe, great scientists like Kepler, Galileo and Newton appeared on the scene, and made noteworthy advances in the different sciences by the practical application of these principles. Kepler took Tycho Brahe's carefully collected data and deduced three famous laws of planetary motion, thus exemplifying the first two principles laid down by Francis Bacon. Galileo was a living example of the inductive method personified in one man. He approached his manifold problems with a perfectly open mind. He would start by collecting as many facts as possible, often making wonderful improvizations, such as using his pulse for recording the movements of a pendulum. When sufficient data had been collected, he would draw a hypothesis from them, but he would not be satisfied with it. He would go a step further, and draw conclusions from his hypothesis which he would test by further experiments. If the conclusions were not confirmed by the results of his experiments, he would abandon the hypothesis and start afresh. His greatest contributions were in the fields of dynamics and astronomy, though he left his mark on other sciences as well.

The year of Galileo's death coincided with the birth of the greatest scientist of the seventeenth century—Newton. His contributions in the fields of astronomy, optics, mathematics, mechanics, etc., are so many that it is not possible even to summarize them here. His discovery of the law of gravitation alone, which seemed to apply from the macroscopic to the microscopic, was monumental. The discovery of the differential calculus placed a powerful weapon in the hands of the mathematicians. The mechanics, which came to be known by his name, became the framework in which all new discoveries for the next two centuries fitted so well, and in which no chinks were observed until the theories of quanta and relativity made their appearance on the scene. More important than all, Newton's work and the discoveries of his successors helped to give science a philosophy of its own in the succeeding centuries.

The eighteenth century saw discoveries in practically all the branches of science. They helped to upset many old fallacies that had persisted up to the time, and they laid the foundations for the great scientific theories which were to follow. In mathematics, Laplace took Newton's work further and also attempted a theory of the cosmos. In chemistry, the outstanding work of Lavoisier ended the false concept of 'phlogiston', and thus laid the foundations of the modern theory of heat. Another fallacy of the old times, namely, that water was one of the four elements, was thrown overboard by the work of Cavendish, who showed that it could be split up into gaseous elements, namely, oxygen and hydrogen. There were, similarly, advances and discoveries in the fields of botany, zoology and physiology, too numerous to relate, but all of which helped to give a clearer and truer picture of Nature to man. As a result of the success with which Newtonian mechanics was able to explain numerous phenomena of Nature which were apparently not connected with one another, and as a consequence of the great discoveries which were made one after the other in the different branches of science, the belief grew stronger that the universe was governed by fixed laws; that it was possible to discover these laws with the help of science; and that ultimately science would be able to explain all natural phenomena including man himself. This belief in the rigid working of the laws of cause and effect, which could be discovered by scientific research, gave birth to the school of thought known as determinism or materialism. However, while the scientific discoveries in the eighteenth century were giving enormous confidence to scientists in the efficacy of the scientific method in explaining natural phenomena, the philosophers were not idle, and they attempted to show the shortcomings of this particular line of approach. Locke emphasized the necessity for continual adaptation to varying needs

and requirements of the time; and, thereby, inculcated a healthy scepticism against any fixed outlook. Berkeley reacted strongly to the materialistic view held by some of the scientists, and denied reality to matter. Hume went one step further and denied reality even to mind. Immanuel Kant, however, took a middle course, and attempted a synthesis of scientific discoveries with philosophical concepts in which, while admitting the necessity of the study of Nature by observation and experiment, he tried to show the limitations of the knowledge gained in this fashion.

The cautious or even negative approach of philosophers like Kant, Berkeley and Hume, however, could not stem the great tide of scientific discoveries, which continued with ever-increasing force and widening scope in the nineteenth century, which may be called the 'scientific age'. Since reliable experiments could not be performed without exact units of measurements, a great deal of work of fundamental importance was done on the primary units of length, mass and time, and the secondary units derived from them. Dalton tackled the problem of the ultimate constitution of matter, and, reviving the work of the ancient Greek Atomists, built up the ground floor of the modern atomic theory in which subsequent advances in chemistry were made. A great deal of work was done on the imponderable fluids, namely, the ether, electricity and heat, and the phenomena connected with them. Young, Fresnel and Huygens revived and developed the wave theory of light, which had been suppressed by Newton's opposition and which postulated the existence of an all-pervading ether. Faraday took up the study of electricity and magnetism, and not only brought about revolutionary changes in our concepts, but also made possible the tremendous advances in electromagnetism which took place after his time. Clerk Maxwell developed the electro-magnetic theory of light, which bridged the gulf between electricity and light, and thus acted as a brilliant pointer to the ultimate oneness of scientific knowledge. Joule, by his researches on the relationship between heat and work, laid the foundations of the modern theory of thermodynamics, which was taken many stages further by Carnot. These discoveries in the experimental and theoretical fields no doubt produced deep changes in the scientific outlook, and confirmed the earlier confidence of the eighteenth century in the ability of science to explain all natural phenomena. None of them, however, produced such revolutionary currents of thought as Darwin's theory of evolution, which by its nature and implications came into conflict with the current theological ideas on such fundamental questions as free-will and moral behaviour.

The relationship between science and philosophy has been undergoing a remarkable change. In the beginning, as a legacy of the Scholastic School, philosophy dominated science. The philosophers, with their training for the search of 'reality' and with their ability for analysis of material phenomena and mental processes, took the leading place. They attempted to synthesize scientific discoveries into complete systems. Later on, however, science and philosophy parted company. The separation became pronounced after Hegel, who under-rated the role of experiment and taught that 'reality' could be achieved by abstract thought. Science could not accept this position without sacrificing some of its great principles and discoveries. Still later, science attempted to develop a philosophy of its own, the first attempt of the kind being made by Ernest Mach. The attempt on the part of science to have its own philosophy has been stimulated greatly by discoveries in the field of biology. So far a great majority of the revolutionary discoveries had been in the field of physics, chemistry, astronomy and mathematics, which did not seem to have a deep impact on life or on man's concept of himself. But Mendel's laws of inheritance, the statistical study of heredity, and the biophysical and biochemical discoveries which took place in the nineteenth and twentieth centuries had a profound effect on scientific thought. The construction of large telescopes, which took man's vision into the distant reaches of the skies, and the manufacture of microscopes, which gave him an insight into the constitution and function of the micro-organisms bordering on the molecules, gave further support to science in developing its own philosophy. All these discoveries strengthened belief in the ability of science to solve ultimately the mystery of matter, energy and life with analytical methods based upon Newtonian mechanics.

When we come to the twentieth century, however, the picture begins to assume a somewhat different shape; and the tremendous confidence of the nineteenth century is assailed by many doubts and uncertainties. We have first the discovery of the quanta and the development of the quantum theory, which represents a break with Newtonian mechanics. We then have the discovery of the electron, the behaviour of which could not be explained on the classical lines. Then came the development of the theory of relativity, which rejected the concepts of absolute time and space. The hard indivisible atom was found to be a small world, with electrons revolving around a nucleus, while quantum mechanics, and not the classical mechanics, was able to explain the phenomena of radiation emitted by atoms in the excited state. Even so, the explanation, if it can be called one, was partial; for an element of uncertainty seemed to be inevitable, and became greater the more we probed into the innermost nature of matter. The epoch-making discoveries of J. J. Thomson, Rutherford, Röntgen, Curie and Becquerel, and the theories of Planck, Einstein, Niels Bohr, Schrödinger and others, while enlarging our vista a hundred-fold, unfolded a thousand new problems. Radiation presented a double-faced appearance. In certain respects it behaved like continually expanding waves; in others like discrete particles of energy which kept their entity regardless of time and distance. Ultimately, in the hands of Heisenberg, even material particles remained no more than wave systems. Now, all these discoveries of the twentieth century which deny the existence of absolute time and space, which inform us that we can either determine the motion of an electron or its position but not both, which tell us that change is not always continuous but often takes place by fits and starts, which state that we know what happens when an electron jumps from one orbit to another, but we do not know what happens to it in the meantime, which advise us that matter and energy are interchangeable and that both can be represented by wave-systems—these have re-orientated our attitude towards that determinism which characterized the eighteenth and nineteenth centuries. Some scientists are now not so sure that scientific method alone can solve all the mysteries of life, or can be successful in giving us a perception of the 'reality'. But, notwithstanding these misgivings, we may say in the words of Sir William Dampier

that, "in spite of ignorance, folly and passion, the scientific method has won field after field since the days of Galileo. From Mechanics it passed on to Physics, from Physics via Chemistry to Biology, from Biology to Psychology, where it is slowly adapting itself to unfamiliar ground. There seems no limit to research, for as has been well and truly said, the more the sphere of knowledge grows, the larger becomes the surface of contact with the unknown".

This brief survey has revealed three salient features. In the first place, the spirit of inquiry, which is essential for scientific advance, is latent in the human mind. This spirit of inquiry has made its appearance at different times, in different lands and among different peoples. Secondly, this seed will not grow, this spirit will not blossom, in an atmosphere of suppression, inhibitions and restrictions. It must have freedom—freedom to think, freedom to speak, freedom to discuss, freedom to exchange ideas with others. If restrictions are imposed upon it, if it is fettered with chains, which may be those of authority, superstition, habit or prejudice, the spirit of inquiry will remain dormant, and ultimately it may even be extinguished. In order that the spirit of inquiry implanted in our souls may blossom fully and flourish, freedom of thought, freedom of speech and freedom of expression are essential. Science can recognize only its own ideology. If attempts are made to impose any other ideology upon it, it can only be to the detriment of scientific advance and progress. The third salient feature which should be apparent from this historical survey is that all attempts to formulate a comprehensive system, aimed at explaining everything, have failed in the past when human knowledge was not so vast. Now that the bounds of knowledge have been vastly extended, such attempts, if made now or in the future, are bound to be even bigger failures. Those who claim to offer comprehensive systems, complete in themselves, as explanations for everything there is to be explained, are ignorant of the nature and extent of our knowledge; and unless they are themselves mistaken, they are attempting to mislead others. Although all knowledge is fundamentally interlinked, progress is possible by making advances on its different sectors. This progress, though it may not be spectacular, is sure and certain. Only thus may we look forward to the gradual lifting of the mists which hide 'reality' from our vision.

# NEWS and VIEWS

## New York Zoological Society

A NUMBER of changes in the staff of the New York Zoological Park have been recently announced by the New York Zoological Society. The title of director of the Zoological Park, vacant for a number of years, has been revived by the appointment to that position of Mr. John Tee-Van, executive secretary of the Zoo and Aquarium since 1942. Mr. Tee-Van, who has been connected with the Zoological Society for forty-one years, started work as an assistant keeper in the Bird Department in 1911, at the age of fourteen, and five years later became an assistant in the new Department of Tropical Research, working with Dr. William Beebe in research stations in the West Indies, British Guiana, Venezuela, the Galapagos Islands, the Sargasso Sea, Haiti, Bermuda and off the coasts of Lower California, Mexico, Central America and Colombia. His scientific work has been done chiefly in ichthyology, a field in which he has published many papers, and he is a vice-president of the American Society of Ichthyologists and Herpetologists. Since 1940 Mr. Tee-Van has been editor-in-chief for a series of books on "Fishes of the Western North Atlantic". He is a fellow and recording secretary of the New York Academy of Sciences, a member of the Boone and Crockett Club and president of the Explorers Club.

Other changes are as follows. Dr. Leonard J. Goss, veterinarian since 1939, has been made assistant director of the Zoological Park and will continue as veterinarian. Mr. Lee S. Crandall, general curator since 1943, is retiring from active administration of the mammal and bird collections, although he will continue to maintain an office at the Park and will be engaged in the preparation of books on the care, feeding, maintenance and exhibition of wild animals in captivity, based on his experience of forty-four years with the collections of the Bronx Zoo. Mr. Robert M. McClung, who has been assistant curator of mammals and birds under Mr. Crandall since 1949, has been appointed acting curator of the department. Mr. McClung is a graduate of Princeton and Cornell Universities and is the author of several animal books for children. Dr. William Beebe, who is retiring with the title of director emeritus of the Department of Tropical Research, is the only member of the staff of the Zoological Park who was connected with it before the actual opening of the Zoo in 1899. He was curator of birds during 1899–1920 and since then has been director of a separate Department of Tropical Research, under which field-stations have been maintained in many parts of the American tropics, and oceanographic work in both the Atlantic and the Pacific has been undertaken. One of Dr. Beebe's best-known exploits was the descent in the bathysphere to the record depth of 3,028 ft. off Bermuda on August 15, 1934. Dr. Beebe expects to go to Trinidad later this year and to resume research in the ecology of the Arina Valley, on which he has been engaged for the past two years. Miss Jocelyn Crane, a member of the staff of the Department of Tropical Research since 1930 and research zoologist since 1942, has been made assistant director of the Department. Miss Crane, who is a graduate of Smith College, is at present engaged in a study of the biology and behaviour of various invertebrates and sense perception in insects.

## Jacobus Henricus van't Hoff (1852–1911)

ONE of the founders of modern physical chemistry, whose work also profoundly influenced physiology, biology, geology and mineralogy, Jacobus Henricus van't Hoff was born at Rotterdam a century ago, on August 30, 1852. Educated at Delft, Leyden, Bonn and Paris, he obtained his doctorate at the University of Utrecht in 1874, after having already published a pamphlet which laid the foundations of stereochemistry. An amplified version in French, "La chimie dans l'espace", appeared in 1875. Van't Hoff

showed that optical activity and the existence of two optically active isomers, differing merely in the sign of their rotations, occurred only when an asymmetric carbon atom was present. A short period as *Dozent* in physics at the Utrecht State Veterinary School was followed by a move to Amsterdam, where at the age of twenty-six he became professor of chemistry, mineralogy and geology at the newly created University. In his classic "Études de dynamique chimique" (1884) he successfully applied the laws of thermodynamics to the problems of chemical equilibrium and affinity, and two years later he evolved his famous theory of solutions, which helped to develop the theory of electrolytic dissociation and modern electrochemistry. In 1896 he accepted a research professorship in chemistry at the Royal Prussian Academy of Sciences in Berlin. Among his many-sided investigations his study of oceanic salt deposits inaugurated a new era in experimental mineralogy. His numerous honours included the Nobel Prize for Chemistry (1901), the foreign membership of the Royal Society (1897) and the German order *Pour le mérite*. Van't Hoff was a simple, friendly person, the last years of whose life were clouded with illness, necessitating periods of rest in sanatoria. He died at Steglitz on March 1, 1911.

## Pharmaceutical Society : Research and other Awards

The Pharmaceutical Society has awarded its research scholarship of £300 a year for two years to L. E. Coles, who will be engaged in the School of Pharmacy, University of London, in completing work on the synthetic analogues of the adrenal cortical hormones. Wellcome Pharmaceutical Research Fellowships, each of £350 a year, have been awarded to J. Thomas, for work in the Department of Pharmacy, University of Manchester, on the chemical synthesis of biological activity, particularly bactericidal action, of a new series of quaternary ammonium compounds, and to G. L. Willey, for research at the University of Leeds on the possibility of selectivity of action of nicotine-like stimulant compounds. The Society also made the following awards : Jacob Bell Memorial Scholarship (£150 with £5 worth of books), to T. M. French, of Northampton ; Manchester Pharmaceutical Association Scholarship (£45), to R. A. Alcock, of Ormskirk ; and the Devon and Cornwall Exhibition in Pharmacy (£25), to A. James, of Tiverton.

## Courtauld's Scientific and Educational Trust Fund : Awards

The trustees of the Courtaulds' Scientific and Educational Trust Fund have announced the award for 1952 of the following postgraduate research scholarships in a branch of science related to the textile, plastics and allied industries, which are worth £375 (except where otherwise stated) and are tenable for one year at the institute shown : D. W. Bannister and P. T. Speakman, University of Oxford ; H. W. W. Brett, University of Adelaide ; C. S. Chadwick, Manchester College of Technology ; E. S. Hill, University of Liverpool ; J. W. Ladbury, Imperial College of Science and Technology, London ; D. C. Blackley (renewal of 1951 award), C. J. Pearce, B. D. Stead and C. N. Turton, University of Birmingham ; J. Russell (renewal of 1951 award), Bradford Technical College ; J. Saunders (£93 15*s*., renewal of 1951 award for autumn term only), University of Bristol ; A. E. Somerfield (renewal of 1951 award), Trinity College, Dublin. Postgraduate research scholarships in textile technology, worth £300 a year for two years, have been awarded as follows : E. Attle and S. L. Fitton, Manchester College of Technology ; C. S. Bruce, D. Hardisty, Miss P. Harris and J. A. Leathley, University of Leeds.

## Common Names of British Insect Pests

In 1944 the Conference of Advisory Entomologists and the Pests and Diseases Committee of the Association of Applied Biologists set up a joint sub-committee to prepare a list of common names of the insect and related pests of garden plants, domestic animals, stored products and timber as they occur in Britain. The first part, dealing with slugs and snails, eelworms, beetles, hymenopterous insects and flies, was published in 1947. The second part, dealing with lice, thrips, plant bugs, aphids, and scale insects, Lepidoptera, fleas, mites and ticks, has recently appeared. Both parts consist of alphabetical lists of the accepted British common names (often with the American equivalents) and the corresponding scientific names ; and alphabetical lists of the scientific names (under genera) and the recommended common name. These lists will be of great value to all applied entomologists in Great Britain in enabling them to secure some degree of uniformity in the names of their pests. Not all the names will have equally ready acceptance by everyone. It is interesting to find the editor admitting quite frankly that "by the very nature of the International Rules governing Zoological Nomenclature the scientific names must constantly be subject to revision". It is intended to publish revised lists from time to time. Copies of the list can be obtained from Miss Barbara M. Stokes, Entomology Department, Rothamsted Experimental Station, Harpenden, Herts (Part 1, 2*s*. ; Part 2, 3*s*.).

## Scientific Papers Published in the Middle East

List No. 6 (December 1950) of "Scientific Papers published in the Middle East", issued by the Unesco Middle East Science Co-operation Office, Cairo, covers papers published in Cyprus, Egypt, Iran, Iraq, Israel, Lebanon, Pakistan, Sudan, Syria and Turkey, and received by the Office between March 1 and November 1, 1950. Publications from Pakistan are included for the first time, and the issue includes more than thirteen hundred titles, arranged under the Universal Decimal Classification. There is also a list of periodicals included, arranged by country of origin, and a list of abbreviations used. Roughly two-fifths of the entries fall under the medical sciences, one fifth in engineering and various industries, and one fifth in agriculture, forestry or stockbreeding. An author index covering the first six lists published by the Office at Cairo (pp. 27) has also been issued. With regard to Arabic names, only the last (according to Egyptian usage) has been retained as surname, and, whenever possible, only one spelling has been selected in the transliteration of Arabic sounds.

## British Interplanetary Society

The annual report of the British Interplanetary Society for 1951 (pp. 18 ; from the Society, 157 Friary Road, London, S.E.15 ; 1951) shows a remarkable enthusiasm among its fellows and members, and also a keen public interest, judging from the number of lectures delivered during the 1950–51 session. Although the Society has been in existence for only six years, it appears that its expansion has been such that a full-time clerical

worker is necessary. Membership is open to all, no technical or other qualification being required, and now numbers about fifteen hundred—a remarkable achievement in six years. Fellowship is restricted "to those who possess some relevant scientific, technical or professional qualifications", and its requirements are specified under seven categories which range from a degree, from a recognized university, in mathematics, engineering or medicine, to "considerable contributions to the development of astronautics". A recent issue of the *Journal* of the Society (11, No. 1, January 1952) contains a number of articles, including one by Oscar Schachter with the title, "Legal Aspects of Space Travel". It is suggested that there will be a demand that the use of outer space for military purposes should be outlawed, and Mr. Schachter seriously states that it does not seem to be too early for governments to give consideration to this aspect of the problem.

## Museum of Applied Science of Victoria : Annual Report for 1950–51

THE annual report for 1950–51 of the Museum of Applied Science, Victoria (pp. 13 ; from the Museum, Melbourne, 1952), includes some interesting remarks concerning policy. When the Museum was established in 1870, its main functions were twofold, to give guidance to artisans and to accumulate a complete record of technological achievement in the form of exhibits. The former function has long since passed to organized technical education, and to some extent the latter has collapsed under its own weight. The past half-century has been one of unparalleled scientific achievement, with the consequence that science museums of moderate means have experienced difficulties in keeping abreast with modern knowledge. But the Museum staff are viewing their responsibilities in a new perspective and now tend to concentrate their attention on the presentation not of an uncritical accumulation of scientific material, but on selected facets that give the layman an understanding of the impact of science on society, preserving a careful balance between the historical and the modern, and exploiting new ideas of display.

## British Internal Combustion Engine Research Association : Elections

AT the recent annual general meeting of the British Internal Combustion Engine Research Association, the following elections were made : *President*, Viscount Falmouth ; *Vice-Presidents*, Air Commodore F. R. Banks, Dr. S. F. Dorey (chief engineer surveyor, Lloyd's Register of Shipping), Sir Lynden Macassey (independent chairman of the British Internal Combustion Engine Manufacturers' Association), Vice-Admiral (E) the Hon. Sir Denis Maxwell (engineer-in-chief of the Fleet), Major-General H. E. Pyman (director-general, Fighting Vehicles Division, Ministry of Supply) and Lieutenant-General Sir Frederick Wrisberg. At the same meeting, a new and smaller representative Council was elected as follows : Mr. H. N. G. Allen (*chairman*), Mr. Miles Beevor, Mr. G. W. Bone, Mr. F. A. Perkins, Mr. C. G. Tangye and Mr. A. C. Yeates, with Mr. C. A. Spencer as the representative of the Department of Scientific and Industrial Research.

## International Geographical Congress

THE Seventeenth International Geographical Congress, held at Washington, D.C., during August 7–15, attracted a record number of nearly 1,500 registrations, of whom 1,200 were actually present. More than five hundred delegates came from the forty-one countries adhering to the International Geographical Union. At the concluding General Assembly, Prof. L. Dudley Stamp (Great Britain) was installed as president in succession to Prof. G. B. Cressey (United States), who becomes vice-president, and Mr. G. H. T. Kimble (American Geographical Society of New York) was re-elected secretary-treasurer. The remaining six vice-presidents to be elected were His Excellency Dr. Hans W:son Ahlman (Sweden), Prof. Hans Boesch (Switzerland), Prof. George Kuriyan (India), Prof. Orlando Ribiero (Portugal), Prof. Max Sorre (France) and Prof. H. O'R. Sternberg (Brazil). By a large majority the Assembly accepted the invitation of Brazil to hold the eighteenth Congress in Rio de Janeiro in 1956. Prior to the Washington meeting, many of the delegates had participated in the centenary celebrations of the American Geographical Society, at which J. M. Wordie, president of the Royal Geographical Society, received the Daly Gold Medal.

## Chemistry of Cement : Symposium in London

THE Cement and Concrete Association, in conjunction with the Building Research Station, is organizing an international symposium on the chemistry of cement, to be held in the Royal Institution, Albemarle Street, London, W.1, on September 15, and in the Royal Society of Arts, John Adam Street, Adelphi, London, W.C.2, during September 16–19. The symposium will be under the presidency of Sir Ben Lockspeiser, secretary of the Department of Scientific and Industrial Research, with Sir Francis Meynell, director of the Cement and Concrete Association, as vice-president. The five sessions, to be held on successive days, will be devoted respectively to the following topics : introductory addresses (followed by two papers and discussion) ; the constitution of Portland cement ; the setting and hardening of Portland cement ; special cements ; and applications of research. The sessions will be mainly devoted to the reading of papers and subsequent discussion. A number of excursions have been arranged (with one on September 14 and several on September 20) and these include visits to the Building Research Station and to the Research Station of the Cement and Concrete Association. Attendance at the symposium is by invitation only. Further information can be obtained from the organizing secretary, Philip Gooding, Cement and Concrete Association, 52 Grosvenor Gardens, London, S.W.1.

## French Metallurgical Society : Autumn Meeting in Paris

THE Société Française de Métallurgie will hold its 'Journées Métallurgiques d'Automne' during October 20–25 at the Maison de la Chimie, 28 bis rue St. Dominique, Paris 7e. The two main subjects to be discussed will be : faults and fractures observed in metals during service ; and methods of effecting economies in metals in short supply, including the rational use of alloys and the substitution of different varieties or qualities of alloys or methods of fabrication to ensure the best possible use of scarce elements. A few communications on other subjects of particular interest will be allowed at some of the sessions. The programme will include communications by metallurgists from many European countries and from the

United States. A number of visits, including one to the new laboratories of the Institut de Recherches de la Sidérurgie, at Saint-Germain-en-Laye, will also be arranged. Other visits and a banquet will be held during the week. Those desirous of attending the meeting should write to the secretary of the Society at 25 rue de Clichy, Paris 9e, from whom all further information can be obtained.

## Colonial Service: Recent Appointments

The following appointments have recently been made in the Colonial Service: D. R. N. Brown (agricultural officer, Uganda) and D. F. Stewart (senior agricultural officer, Uganda), assistant directors of agriculture (field), Uganda; J. C. K. Marshall and F. S. Walker (senior assistant conservators of forests, Federation of Malaya), conservators of forests, Federation of Malaya; W. H. Reeve (chief geologist, Northern Rhodesia), director of the Geological Survey, Northern Rhodesia; Dr. J. A. Simpson (biochemist, Federation of Malaya), chief biochemist, Federation of Malaya; R. A. Robinson, plant pathologist, Kenya; R. J. Isaacs, livestock officer, Nyasaland; I. A. D. MacKenzie, assistant conservator of forests, Nigeria; J. G. McGregor and B. Woodacre, assistant meteorologists, West African Meteorological Service, Nigeria.

## The Night Sky in September

Full moon occurs on Sept. 4d. 03h. 19m., U.T., and new moon on Sept. 19d. 07h. 22m. The following conjunctions with the moon take place: Sept. 9d. 03h., Jupiter 7° S.; Sept. 21d. 02h., Saturn 7° N.; Sept. 21d. 14h., Venus 6° N.; Sept. 25d. 18h., Mars 3° N. In addition to these conjunctions with the moon, Venus is in conjunction with Saturn on Sept. 15d. 23h., Venus being 1·6° S. Mercury is a morning star, rising at 3h. 55m. and 4h. 50m. at the beginning and middle of the month, respectively, in the latter case about fifty minutes before sunrise, and after this it becomes more difficult to observe. On Sept. 6d. 20h. it is in conjunction with Regulus, Mercury being 0·9° N. Venus, an evening star, sets at 19h. 20m., 18h. 55m. and 18h. 25m. on September 1, 15 and 30, respectively. Its stellar magnitude is − 3·3, and more than 90 per cent of its illuminated disk is visible. Mars, an evening star, sets at 21h. 10m., 20h. 45m. and 20h. 25m. at the beginning, middle and end of the month, respectively, its stellar magnitude varying from 0·4 to 0·6. At the beginning of September the planet is a little south of β Scorpii, and about a week later it is north of Antares, magnitude 1, with which it could be confused owing to its ruddy colour; but Mars is a little brighter than the star. Jupiter is visible throughout the night, its times of rising being 21h. 05m., 20h. 10m. and 19h. 10m. on September 1, 15 and 30, respectively, stellar magnitude − 2·2. Saturn, an evening star, is too close to the sun for favourable observation, setting less than an hour after the sun during the greater portion of the month. No occultations of stars worth observing occur at Greenwich during September. Vernal equinox occurs on Sept. 23d. 02h.

## Announcements

Prof. F. Blakemore, professor of veterinary medicine in the University of Bristol, has been appointed a member of the Agricultural Improvement Council for England and Wales in succession to Sir Thomas Dalling, who is taking up a post in the United Nations Food and Agriculture Organization.

Dr. G. P. Contractor, acting director of the National Metallurgical Laboratory, Tatanagar, India, has been appointed to the additional post of ex-officio director of inspection (metallurgy), Tatanagar, in the Directorate General of Supplies and Disposals, of the Ministry of Works, Housing and Supply, India.

The Alvarenga Prize for 1952 of the College of Physicians of Philadelphia has been awarded to Dr. Norbert Wiener, professor of mathematics in the Massachusetts Institute of Technology, for his contribution to the field of cybernetics. The Prize is an annual award and was established in 1883 by the will of Pedro Francisco DaCosta Alvarenga, of Lisbon, Portugal, an associate fellow of the College.

The annual exhibition of the Amateur Entomologists' Society will be held at Buckingham Gate Central Schools, Wilfred Street, London, S.W.1, on September 27, starting at 2 p.m. The Society welcomes anyone interested in entomology. Further particulars can be obtained from K. H. Bobe, 19 Hengist Avenue, London, S.E.12.

The fourth exhibition and symposium of the Electrical and Electronics Section of the Scientific Instrument Manufacturers' Association will be held in the Examination Hall, 8–11 Queen Square, London, W.C.1, during September 2–5. Further information can be obtained from the secretary, A. G. Peacock, Scientific Instrument Manufacturers' Association, 20 Queen Anne Street, London, W.1.

The firm of W. Watson and Sons, Ltd., is holding an exhibition on "The Microscope in Industry and Research" in the Lecture Room of the New Horticultural Hall, Westminster, London, S.W.1, during September 15–19 (September 15, 2–6 p.m.; September 16–18, 10 a.m.–6 p.m.; and September 19, 10 a.m.–4 p.m.). A brochure referring to the exhibition can be obtained from W. Watson and Sons, Ltd., 313 High Holborn, London, W.C.1.

The Third International Congress on Astronautics will be held in Stuttgart during September 1–6. Further information can be obtained from the Gesellschaft für Weltraumforschung, Greutterstrasse 18, Stuttgart-Weilimdorf.

A symposium on "The Applications of Photography to Research at the University" will be held by the Scientific and Technical Group of the Royal Photographic Society on October 4 in the Zoology Department, Downing Street, Cambridge. The wide variety of uses made of photographic techniques in the research work carried out in the University of Cambridge will be considered, including the topics of high-speed photography, electron microscopy, colour photography and flash cinematography. Brief papers will be read, with time for discussion after each. Further details can be obtained from the honorary secretary, Mr. D. H. O. John, c/o May and Baker, Ltd., Dagenham, Essex.

In the obituary appreciation of Prof. H. Kramers published in *Nature* of July 19, we inserted the description "professor of theoretical physics in the Technical University of Delft". Prof. L. Rosenfeld writes: "from 1936 until his death, Kramers's main position was that of professor of theoretical physics in the University of Leyden. It is true that he also held concurrently a so-called 'special professorship' at the Technical University of Delft, but this was a secondary position, involving only very slight duties."

# MEDIUM-ENERGY NUCLEAR PHYSICS

## CONFERENCE IN PITTSBURGH

THE University of Pittsburgh sponsored a conference on medium-energy nuclear physics which met in Pittsburgh during June 5–7. There were five sessions at which invited papers were given, followed by informal discussion. The first paper was that by G. Scharff-Goldhaber (Brookhaven National Laboratory) under the title "Excited States of Even–Even Nuclei", in which she discussed the energy-level separations and the spins of the excited states of these nuclei. Regularities in these quantities are found when the nucleus is thought of in terms of the shell model, where most nuclear properties are ascribed to the nucleons outside the 'closed shells'. An instructive model showing the excitation energy of the first excited states of nuclei, based on the General Electric isotope chart, was also shown. This paper was followed by one by R. F. Christy (California Institute of Technology) with the title "Selection Rules and Coupling Rules in Light Nuclear Reactions". Dr. Christy proposed that there may be parameters descriptive of nuclei which are almost good quantum numbers for light nuclear reactions. Among these are the isotopic spin $T$ and the partition numbers ($p$, $p'$, $p''$) of Wigner. Finally, he mentioned certain reactions which are consistent with Russell–Saunders coupling in nuclei and not with $j$–$j$ coupling.

At the second session of the conference papers were read by M. E. Rose (Oak Ridge National Laboratory), S. Ridgway (Princeton University) and S. T. Butler (Cornell University). Dr. Rose, speaking on the "Angular Correlation of Nuclear Radiations", said that he was particularly interested in the effect on angular correlations of external perturbations acting on the nucleus. These lead to quenching of the angular correlation. He also described the principles which enable one to deduce the value of the magnetic moment of a nucleus in the state between the emission of two successive gamma-rays. Dr. Ridgway reported on studies of the angular correlation between beta-rays and subsequent gamma-rays. This correlation has been investigated theoretically and depends on the Coulomb correction factor in the spectrum. Experiments have been done on several nuclei, including arsenic-76 and antimony-124. The third speaker, Dr. Butler, outlined the physical principles underlying his calculations of the angular distributions resulting from stripping reactions. A stripping reaction is one in which a deuteron is incident on a nucleus, the nucleus absorbing either the proton or the neutron from the deuteron and making a direct transition to its final state, the other constituent of the deuteron going past. The energy and angular distribution of the unabsorbed particle give information about the state of the absorbed particle in the final nucleus. Dr. Butler then showed how the effect of the Coulomb interaction between the incident proton and the nucleus could be taken into account, both when the neutron and when the proton is absorbed.

H. W. Fulbright (University of Rochester), H. J. Richards (University of Wisconsin) and H. E. Gove (Massachusetts Institute of Technology) were the speakers for the third session of the conference. Discussing "Observations of Angular Distributions in some $(d,p)$ and $(d,n)$ Reactions", Dr. Fulbright said that the study of the beta-decay of certain elements, notably carbon-14, does not lead to complete understanding of the states of the nuclei involved. The theory of Butler, described above, provides an alternative approach to this problem. If the measured angular distribution from a stripping reaction fits one of Butler's theoretical curves, the angular momentum state of the absorbed particle can be inferred. Good enough agreement with such curves has been found to allow the inference, for example, that carbon-14 and nitrogen-14 ground-states have even parity. Dr. Richards, in the next paper, gave a detailed account of the assignments of spins and parities to the energy-levels of boron-10. He showed how the information from many kinds of experiments can be fitted together to yield a consistent assignment, and indicated the sources of some ambiguities. Dr. Gove then presented some results obtained with the cyclotron at the Massachusetts Institute of Technology. These included some energy-levels obtained by the inelastic scattering of protons and by stripping reactions. The angular distributions from stripping reactions were compared with those predicted by Butler and by Tobocman and Friedman. There appears to be a systematic angular displacement towards larger angles than those predicted.

For the fourth session of the conference there were three prepared contributions by, respectively, D. R. Inglis (Argonne National Laboratory), and by A. de-Shalit and E. P. Wigner (both of Princeton University). Dr. Inglis spoke on the subject "Departures from Nuclear Models in the $p$-Shell". He started by discussing a situation in atomic spectra where two different perturbations, the spin-orbit coupling and exchange effects, cause splitting of the energy-levels. In nuclei this spin-orbit coupling leads to the shell model of the nucleus, while the exchange splitting can be described by the Russell–Saunders coupling. Dr. Inglis then showed how complicated things can become in the intermediate region and discussed the light nuclei in the light of this 'intermediate coupling'. Dr. de-Shalit then pointed out some regularities in the deviations of magnetic moments from the Schmidt lines, in particular the fact that a nucleus with one odd proton has a moment farther from the Schmidt line than the corresponding nucleus with an odd neutron. He proposed an explanation of this in terms of $j$–$j$ coupling. This paper was followed by that of Prof. Wigner, who started by reminding his audience of several well-known "queer facts" about nuclei, consisting of accurate numerical sequences or equalities. He then proceeded to discuss the possibility that spin-orbit coupling nuclear has as its origin the operation of a tensor force between pairs of nucleons in nucleus. Dr. Feingold has made calculations which give, in light nuclei at least, qualitative agreement between theoretical and experimental values of the magnetic moment and the quadrupole moment. The admixtures of states produced by the tensor force are small, so that Russell–Saunders coupling holds to a good approximation.

The three papers given at the concluding session of the conference were by W. W. Buechner (Massachusetts Institute of Technology), R. S. Bender (University of Pittsburgh) and Katherine Way (National Bureau of Standards). Dr. Buechner described the

apparatus used for both low-energy and high-energy precision determinations of energy-levels, using for the latter the new Van de Graaff generator at the Massachusetts Institute. Results have been obtained for a variety of elements, in many places checking with those obtained elsewhere at low energy, and adding many new ones at high energy. Dr. Bender described the unique high-resolution beam analysing system used with the University of Pittsburgh cyclotron. He then summarized the results so far obtained by its use. These consist of energy-levels obtained from $(pp')$, $(p,\alpha)$ reactions; many old levels have been found, some with new precision, and many new highly excited levels have been located. Finally, Dr. Way reported a new set of values for the binding energies of the nuclei above lead, and also in the region around neutron number 50 and atomic number 50. These were obtained by considering closed cycles involving alpha-decay and beta-decay. On the basis of the existing experimental data, differences in binding energies at both the neutron and proton 'magic' numbers showed up clearly.

Discussion leaders for the sessions included Dr. Maria Mayer (Argonne National Laboratory), Dr. Maurice Goldhaber (Brookhaven National Laboratory), Dr. S. T. Butler (Cornell), Dr. G. C. Wick (Carnegie Institute of Technology), and Dr. T. Lauritsen (California Institute of Technology).

Philip M. Steele

## ISOTOPES IN MEDICINE

THE application of isotopes in medicine is a subject which shows signs of dangerous over-popularization, with the consequent unjustified simplifications of the problem. A recent publication, entitled "Isotopes in Medicine"*, must therefore be very welcome since this series of articles, a number of them reviews, by acknowledged authorities in their respective fields demonstrates clearly the limitations as well as the possibilities of the clinical and biochemical applications of isotopes. The title "Isotopes in Medicine" is misleading, since only a few of the direct applications of isotopes in medicine are discussed and a number of papers are devoted to reviews of biochemical investigations which are unlikely to exert much influence on clinical medicine for some time. This, however, is not meant as a criticism of the standard of the material, which is high, and the editor is to be congratulated on his choice.

Isotopes represent an important new weapon in the armoury of the clinician and the biochemist; but it is clear that they rarely provide a short cut to the solution of a given problem, and their use demands not only considerable technical resources but, above all, a wide knowledge and experience of the particular field in which they are to be applied. The use of radioactive isotopes in radiotherapy can only be based on a wide experience of orthodox methods of radiation therapy, as is clear from the contribution to this volume by Ralston Paterson and his colleagues. In biochemical research the use of isotopes has in a number of fields raised rather than solved problems, and advances in the applications of isotopes will, to a very large extent, depend on advances in general biochemical theory and technique.

The basic problem in the clinical application of radioactive isotopes is that of obtaining adequate localization of the isotope within the required tissue. A degree of localization is required for both therapeutic and diagnostic applications, but in therapeutic work a much higher degree of localization is needed in order that the healthy tissues of the body should not suffer too great damage. The concentration of iodine by the thyroid has been made the basis of many diagnostic and therapeutic studies, which are well reviewed in this volume; but it must be admitted that the popularity of thyroid studies with iodine is largely due to the fact that iodine alone of all the elements will achieve by metabolic processes a high degree of localization within the body.

Increasing use is being made in radiotherapy of radioactive isotopes in the form of discrete sources used either externally or within the body. No papers on this aspect of the subject are included, which is perhaps reasonable since the problems are basically technical ones, and the clinical applications follow along the lines of treatment with X-rays and with radium sources. Other methods of providing a localized irradiation of the required tissues are being developed, and two of the recent techniques are discussed. A description is given of the treatment of malignant bladder conditions by a radioactive solution enclosed in a rubber balloon in the bladder, and of irradiation of the pleural and peritoneal cavities by the injection into these cavities of radioactive gold in colloidal form.

The diagnostic application of isotopes involves to a large extent radiation measurements made externally to the patient and thus must depend basically on instrumentation. An application is described of scintillation counting in an attempt to diagnose brain tumours following administration to the patient of fluorescein labelled with iodine-131. So far, in Great Britain, the results with this technique have not been very promising.

One of the most simple and direct applications of radioactive isotopes in diagnosis lies in the study of blood flow. Here a measure is required only of the rate of transport of radioactive material injected into the blood, and valuable clinical applications have been found for this technique, described in several papers of this volume.

On the technical side the volume contains a number of extremely useful articles, in particular that by L. H. Gray entitled "General Principles of Assay and Standardisation of Radioactive Isotopes". A report is also given by members of the staff of the Radiochemical Centre, Amersham, on the availability of labelled compounds, with details of the methods of synthesis of a number of compounds labelled with carbon-14.

L. F. Lamerton

* *Brit. Med. Bull.*, **8**, Nos. 2–3, 111-300 (1952), 18*s*.

## NATIONAL INSTITUTE OF AGRICULTURAL ENGINEERING

### OPEN DAYS

THE National Institute of Agricultural Engineering, at Wrest Park, Silsoe, Beds, held open days during July 22–24, when exhibits were staged to illustrate to visitors the work of the Institute. The exhibits did not cover the whole programme of the work in hand at Wrest Park (which is reported more fully in the recent report for 1949–51 [1]); but, even so, they were quite comprehensive and representative of many aspects of the activities of the departments.

Noticeable features were the use made of instrumentation, comprising standard, modified or specially designed apparatus for use not only under laboratory conditions but also in the field; of techniques devised to meet the great variety of investigations undertaken; and of the experience and facilities of the Institute for developing machinery and equipment primarily for use by other research institutes. Examples of the last were the fertilizer placement machines shown by the Mechanical Engineering Department to meet the needs of research workers at Rothamsted Experimental Station and the Macaulay Institute for Soil Research; the combine harvester, using a new principle of threshing, for harvesting crops grown on plots; an elevator-loader for handling potatoes into covered storage, fitted with a sprout depressant dust-feed, for the Potato Storage Investigation Team of the Agricultural Research Council; and a press for the extraction of protein from macerated leaf which has been developed in association with Rothamsted and the Grassland Research Station.

The Mechanical Engineering Department is responsible for carrying out official tests of tractors and accessories, grain cleaners and driers, and grass driers. A full-scale test of the last was demonstrated, and included a specially designed mobile laboratory. A good deal of equipment has been developed for tractor testing, and that exhibited included a hydraulic loading car, drawbar dynamometers, a mobile belt-dynamometer and a power take-off dynamometer; a mobile trailer weighbridge used for grass-drier tests was also shown.

Research into the design and operation of tractors is proceeding with the help of the foregoing equipment, and a single-wheel tester which has been under development is now completed and will also be used for tractor testing. Research is chiefly concerned with the factors affecting the efficiencies of the engine, transmission and driving wheels; attention is also being given to the possibilities of using hydrostatic transmission, and an experimental motor built into the driving wheel of a tractor was on view.

Tests of agricultural machinery other than that already mentioned are the concern of the Agricultural Testing Department, and examples of the methods and equipment used were to be seen. These included a ploughing-depth recorder; portable weighers for wheels, sacks, bales, etc.; apparatus for collecting the complete contents of a potato ridge *in situ* and for sorting and grading them, for the measurement of the power requirements of machines and the dirt and top tare of sugar beet, and for the calibration and testing of seed drills and fertilizer distributors; and the method used for the detection of mechanical damage to potatoes. The work of this Department also includes investigations into the spring mechanization of sugar beet—a Dixie down-the-row thinner was at work—and the loss of sugar and dirt in field clamps of sugar beet.

The activities of the Horticultural Engineering Department cover a wide field; those displayed related to overhead irrigation, spraying, frost prevention, glasshouse heating and ventilation, tractor steering, the washing of vegetables and the harvesting of onions. Modern techniques such as those employing electronic apparatus have been brought into use; both irrigation and spraying for plant protection call for the production, control and distribution of droplets, and the assessment of the resulting patterns. A high-speed camera is used for the study of spray formation by nozzles of different patterns, and the apparatus and photographs were shown; a dye is used in many of the sprays, and spray patterns were on view—the dye serves both for visual inspection and for colorimetric and gravimetric estimation. In co-operation with the Research Branch of the Post Office Engineering Department, photoelectric scanning apparatus and electronic counters have been adapted for studying spray patterns and providing data as to the number and sizes of the droplets deposited; the apparatus was demonstrated in use[2].

Methods of frost prevention include fans and water sprays, and equipment and results were to be seen.

The apparatus used in the study of glasshouse heating and ventilation was shown, and included instruments for measuring and recording soil moisture, soil and air temperatures, air flow, carbon dioxide concentration, solar radiation and heat losses; the results of this work to date and also those of steam sterilization of soil were displayed.

Research work has been commenced into the problems arising from the design or adaptation of a tractor to meet the exacting requirements of market garden crops. Steering is receiving attention as a primary consideration, and a steering-deviation recorder and a speed and torque recorder were open to inspection. Adaptation has involved reversing the normal driving position and transmission of a tractor and mounting the implements ahead of the front driving-wheels of the reversed tractor in full view of the driver.

Research and development on ploughs and other tillage implements and on potato harvesters have revealed the need for more information about soil conditions, and a section of the department concerned has been formed which is devoted to soil physics; it is now known as the Soil Department. Known methods and new ones have been devised for obtaining, especially in the field, the data required. A soil penetrometer and torsion shear box were shown, and a demonstration was staged to illustrate the effect of compaction of the soil by tractor wheels.

Strain-gauge equipment in conjunction with a mobile laboratory was exhibited, by which the forces acting on a plough, on a tine or on the linkage of direct-mounted implements are recorded.

The development of a satisfactory potato-harvester has engaged the attention of the Institute for a number of years; the experience gained has been incorporated in the latest development, which takes the form of two separate units—a digging unit on a rear-mounted toolbar and employing a disk share for digging, and a rotating spider for separation; the crop can be left on the ground or an elevator can be fitted to deliver into a trailer, which can be fitted with a detachable picking conveyer. The separation of functions makes the arrangement suitable for the small grower.

The drying, handling and storage of cereal crops are the principal interests of the Grain Department; investigations have been carried out to improve the efficiencies of the installations developed—many of which are now in use on farms—and to extend their application, for example, to green crops and overseas products. Experimental plant of different types was on exhibition, including ventilated silos of concrete and fabric, a grain elevator, grain cleaner, platform sack drier used also for green crops, and special apparatus for measuring air flow, temperature, humidity, pressure drop, moisture content, etc.

Field surveys are carried out by the Field Investigation Department, and an independent survey of tractor utilization is in hand. Potato planting and harvesting, sugar beet and grain harvesting, and hay-making are under investigation. Present farming practice is studied, and planned trials, so far as practicable under controlled conditions, are undertaken. Results, methods and equipment were to be seen. A portable windrow weigher has been devised; but much of the apparatus used is that already mentioned in connexion with testing.

The main laboratories, forming the Instrumentation Department, are at the service of all departments. There special investigations are carried out, for example, on the specific heat of soils, ploughshare wear and precision drilling, besides routine calibration and analyses. Moisture content determinations are a prominent feature for which standard methods are not always suitable, and special apparatus has to be devised to cope with a wide variety of products—for example, apparatus was in use dealing with grass, with coffee beans and with tomatoes.

Considerable use is made of photography, including ciné-films; two ciné-films with tape-recorded commentaries were shown in the Conference Room each day; the Library, which handles not only books, bulletins and periodicals but also manufacturers' catalogues and Institute photographs and slides, was open to visitors.

[1] Nat. Inst. Agric. Eng. and Scottish Machinery Test. Stat.: Report October 1, 1949–September 30, 1951. (Silsoe: the Institute, 1952.) 8s. 6d.

[2] See *Nature*, **169**, 519 (1952).

## SPORTS TURF RESEARCH INSTITUTE

### MACHINERY EXHIBITION AND OPEN DAY AT THE ST. IVES RESEARCH STATION

THE combined machinery exhibition and open day of the Sports Turf Research Institute, held during July 15–16 at the St. Ives Research Station, Bingley, proved to be a very successful event of great interest to all users of sports turf. Manufacturers combined to put on show a wide variety of implements used in turf production and maintenance, and to many people it was a revelation to see the amount and variety of machinery called for to uphold modern turf standards in face of the increasingly heavy demands being made on playing areas. Mowing machines of very many types naturally were much in evidence; but there were also, among other things, tractors, fertilizer distributors, line-marking machines, compost shredders, turf-cutting implements, watering tackle, weed sprayers of all sizes and a variety of implements for piercing turf in order to relieve soil compression and facilitate easy ingress of air and water. A wide range of hand- and power-drawn machines was demonstrated. A recent development has been the use of the three-point hydraulic linkage of tractors for operating spiking equipment, while a new power-driven spiker, shown for the first time, roused much interest.

The variety of sprayers on view may be taken as a measure of the interest taken in weed control. On the experimental ground, where a number of current trials were demonstrated, the subject of weed control also received attention. Weedkillers based on 2 : 4 D (2 : 4-dichloro-phenoxyacetic acid) and M.C.P.A. (2-methyl-4-chloro-phenoxyacetic acid) have proved a great boon, but some weeds have proved somewhat resistant and work on these is proceeding. On show were experimental plots treated with 2 : 4 : 5 T (2 : 4 : 5 trichloracetic acid) at various rates with and without admixture with 2 : 4 D and M.C.P.A. Results obtained against clover were very promising indeed, but yarrow control did not appear so good. There were also trials of exfoliated vermiculite for turf establishment and maintenance and on the use of bitumen for toughening turf to withstand heavy wear. Further field trials on view included a number on grass-seed mixtures for various purposes and others on fertilizer treatment. Among the latter must be mentioned a series which must be about the oldest of its type existing, since in it individual plots have received their own particular kind of fertilizer treatment for a period of more than twenty years. The effects of these treatments on botanical composition, pest and disease invasion, drought resistance and the like were easy to see.

Much interest was displayed by visitors in the laboratories which were open to them. The increasing demand for scientific advice is well shown here, since only last year a new chemistry laboratory had to be fitted out to cope with the increasing demand for analytical work, while this year visitors were able to see for the first time the new Biology Department. Though its laboratory space is somewhat limited, the Department has an ambitious programme and is already making its presence felt.

This new Department undertakes routine examinations of diseased turf, the identification of turf plants, and turf pests; in addition, both short- and long-term schemes of research, mainly in the realms of turf diseases, are being conducted. In Great Britain there is not the great variety of turf diseases which may be found in, say, the North American continent, but there are definite problems in need of solution. Improved methods of control of *Fusarium* patch disease are being sought, and new fungicidal materials are on test in the laboratory and in the field for this purpose.

A study is being made of the biology of 'fairy rings' as a necessary preliminary to the devising of methods for their elimination. In the popular literature on turf management much has been written on the control of 'fairy rings'; but trials with reported curative treatments seldom seem to have been conducted under adequately controlled conditions.

## STANFORD RESEARCH INSTITUTE, CALIFORNIA

### REPORT FOR 1951

IN an address, "Research and Industry—Partners in Progress", to the board of directors of the Stanford Research Institute, California, on the occasion of the fifth anniversary of the founding of the Institute, Brigadier-General D. Sarnoff, chairman of the board of the Radio Corporation of America, said that the Institute is an outstanding example of the natural partnership between research and industry. That partnership, he believed, offers the

greatest hope of solving the world's problems and industry's problems. It has always been true that the things men live with largely determine the ideas men live by, and the kind of economy and the kind of government we enjoy are determined mainly by the things industry produces and the use that is made of them. This is not a materialistic doctrine, he said, for there is also a spiritual factor which is possibly the most important, and research itself contributes to this: besides its creative and constructive value, its contribution to economic security and thus to peace, and its challenge to competition, research contributes such values as objectivity and the patient, persistent search for the truth to the partnership on which industrial progress depends. Business, for its part, should contribute understanding and encouragement, as well as finance, and General Sarnoff was emphatic that industry rather than government should bear a main responsibility for the finance of research: government control might destroy the very qualities that enable the research worker to make his most important contribution to society. The future of the Stanford Research Institute, he said, is bright because it recognizes the dependence of applied research on the new knowledge revealed through basic research and maintains a close relation with other research centres throughout the United States.

Some details of the growth of the Stanford Research Institute since 1947 and of its work during 1951 are given in the fifth annual report of the Institute*, which includes a quotation from General Sarnoff's address. Its full-time staff (scientific, technical, managerial and service) increased by 65 per cent during 1951 to 425, and, of the 214 projects on which the Institute was engaged, 184 were for commercial and government sponsors. Expenditure totalled 3·6 million dollars, compared with 1·99 million dollars in 1950, and close affiliation with Stanford University continued to be a vital factor in the development of the Institute.

In the Department of Chemistry, which with a staff of more than seventy-five now conducts research costing 1·2 million dollars annually, among the research projects mentioned in this report are those on the development of a method for the continuous large-scale separation of ionic substances, the efflorescence of latex paint films, the evaluation of ceramic materials, the oxidation of xylenes and the industrial uses of coconut oil derivatives. During the past four and a half years the Air Research Laboratories of the Institute have spent more than 2 million dollars in studying air-pollution problems in different parts of the United States. Besides developing much special equipment, the laboratories have intensified efforts to spread information on air-pollution dangers and their prevention. In the Applied Physics Department an ion-scattering analyser is under construction, and the radiation laboratory is attacking the primary objectives of developing processes using large quantities of radioactive material as a source of penetrating gamma-rays and providing all branches of the Institute with staff and facilities for experimental work with radioisotopes. The Division of Geophysics and Geology is continuing its programme on the development of the Poulter seismic method of surveying underground structures and is undertaking seismic exploration in Western Texas.

* Stanford Research Institute: Annual Report, 1951. Pp. 48. From the Institute, Stanford, California; 1952.)

A staff of 125 is engaged on engineering research, and projects specifically mentioned in the report include studies on aircraft antenna theory and design, automatic assembly techniques for miniature electronic equipment, the development of the three-colour picture-tube system of television based on the Geer principle, and the response testing of pulse transformers. The Department of Industrial Economics, with a staff of sixty-five, has conducted a techno-economic survey of the hard-board industry; economic studies of Cuba and of a proposed crude-oil pipe-line from Edmonton, Alberta, to Vancouver, British Columbia; an investigation, for the United States Atomic Energy Commission, of the technological and economic questions involved in the industrial use of radioactive fission products; and a co-operative survey, with the South-west Research Institute, the Armour Research Foundation and the Battelle Memorial Institute, of fundamental and applied research activities in Western Germany. Biological research continued to expand; and in the biochemical field particular attention was given to problems of nutrition, toxicity, cancer and the effects of radiation, including studies of the effect of fluoride intake on the general health of cattle, the toxicity of chemicals used to prevent mould growth in citrus products, and the effects of X-radiation and radioactive isotopes on normal tissue and tumours.

The Institute continued to publish its "Chemical and Economics Handbook", and investigations sponsored by the Institute itself included a fundamental study of chemical reactions in aerosol systems, the design of a special still-head which eliminates the need for a separate receiver changer, a study of Goetz molecular filter membranes for the removal of pyrogens from aqueous media, the development of a fractionating column efficient at low pressures, the development and application of paper-chromatographic techniques, the reactions occurring between polymer molecules and the free radicals present during the formation of vinyl polymers, and a study of the applications in analytical chemistry of ion-exchange resins.

## HOUSING IN THE U.S.S.R.

A BRIEF survey of housing development in the U.S.S.R. from 1917 until the present day by Dr. E. M. Chossudovsky (Housing and Town and Country Planning, Bull. 5, United Nations Publication) shows that the material difficulties with which the Government has had to deal have been formidable. The housing resources taken over by the Soviet authorities after the Revolution were both quantitatively inadequate and in appallingly poor condition. Very little new construction took place until the late 1920's, and it was not always possible to devote sufficient attention to repair work, so that the pre-revolutionary level of housing was restored less quickly than that of the other branches of the economy.

With the beginning of the era of the Five Year Plans (1928–29) the situation improved; altogether before the Second World War about 113 million square metres (approximately 1,216 million square feet) of urban living space had been constructed since the inception of the Soviet regime. Much was done by way of improving the quality of housing, developing and improving municipal services and providing communal buildings of all kinds.

Two hundred new cities were built between 1926 and 1939, in conformity with the changing character and distribution of the population and the development of the country's eastern areas. Yet, despite all this progress, it proved impossible to bridge the gap between population growth and housing; housing construction lagged behind the rate of industrialization, and the urban population increased at an exceptionally rapid rate. Further, much of the pre-revolutionary housing proved to be beyond repair and had to be scrapped, thus slowing down the net growth of the total housing fund.

The war-time destruction of housing amounting to some 30 per cent of the total amount of urban housing, and the extensive and frequently complete destruction of rural housing proved a serious setback. The over-fulfilment of the total urban housing programme of the post-war Five-Year Plan has, however, more than offset the tremendous losses and led to a far-reaching, even revolutionary, modernization of the building industry (especially in the application of express and even-flow methods of erecting houses), which should make it possible to step up housing construction in subsequent five-year plans to a marked extent. The pace of the country's house-building has been appreciably increased by the financial and material assistance accorded to individual house-building by the authorities.

In the present stringent housing situation, the Government has controlled the distribution of available housing resources, taking into consideration the priority claims of ex-servicemen, the dependants of war casualties and invalids, the partisans and their families. The relationship between work (type, quantity and quality) and the allocation of limited housing resources, already recognized before the War, has now been further strengthened; it is possible to ensure that the housing requirements of such key workers as the miners are promptly met. Special housing facilities also are provided to meet the needs of workers who settle in newly developed regions. Housing is thus regarded as one of the instruments for increasing the productivity of labour and building up permanent staffs in industry.

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# MUSEUMS ASSOCIATION

## ANNUAL CONFERENCE IN OXFORD

THE fifty-eighth conference of the Museums Association was held at Oxford during July 21–25 under the presidency of Mr. S. D. Cleveland, director of the City Art Gallery, Manchester, and was attended by more than three hundred and fifty delegates from both national and provincial museums. This was the third occasion on which the Association has visited Oxford, the previous time being in 1919.

In his presidential address, on "The Inevitability of Museums", Mr. Cleveland stated that it is necessary to correct a prevailing misconception by which museums are regarded as educational institutions only. It is true, he said, that education must be an integral part of their work; but it should take its place with the other functions of collection, conservation, interpretation, research and service to the community.

Dr. H. J. Plenderleith, keeper of the Research Laboratory at the British Museum, in a paper on "Fakes and Forgeries", described his subject as a very human study in which the man of science can help the scholar. In fact, the intimate co-operation of these two is essential, and there must be complete sympathy with each other's aims and methods. He enumerated some of the physical and chemical methods used at the British Museum, and spoke of the difficulties encountered when it is necessary to form an opinion without even marking the object.

Sir Philip Hendy, director of the National Gallery, stressed that the primary function of museums and art galleries is to be a Temple of the Muses and that no secondary function should be allowed in any way to interfere. Museums are guardians of a high standard of quality. He spoke in favour of the production of good reproductions of first-class paintings and pleaded for a more liberal interpretation of the function of art galleries.

In a session of a rather more domestic nature, the story of museums in Oxford was told by the five directors concerned. In all the papers, and in the subsequent discussion, it was apparent that the pendulum is swinging once again with regard to the amount of material that should be displayed in museums. From showing everything, the general tendency a few years ago was to show almost nothing. Now a compromise has been made, and it is realized that the arrangement as seen in the windows of the departmental stores is not the ideal prototype for museum cases. The apathy of the University of Oxford towards its museums was commented upon by several speakers, and the hope expressed that one result of the conference on the part of the University would be an increased interest in the value of its great collections. The hope was also expressed that the City of Oxford would consider the establishment of a museum to illustrate its own history.

Speaking on "Changing Fashions in Museum Teaching", Mr. Peter Floud, of the Victoria and Albert Museum, London, emphasized the value of making use of the galleries in addition to the children's rooms which are now established in so many museums. There is a distinct danger that museum work may become simply an extra-mural function of the school. He also dealt with the three-dimensional didactic displays which produce indirect museum teaching, and illustrated his remarks with actual examples of exhibition work. Dr. C. H. V. Sutherland, of the Ashmolean Museum, Oxford, said that there is a real public interest in numismatics and that museums should make every effort to satisfy this. He agreed that there are few trained numismatists in Great Britain, and stated that a British association of the various numismatic societies would probably be formed in the near future. He hoped that the Museums Association would co-operate in this matter. Mr. J. W. Y. Higgs, of the Museum of English Life, Reading, described this new museum of English rural life and stated how, as a nation, England is deeply conscious of its rural history.

At the annual general meeting of the Association, held during the conference, a protest was made against the cuts in Treasury grants to national museums and art galleries. The Association decided to send to the Chancellor of the Exchequer a resolution deploring the cuts as "gravely endangering the safety of the national treasures and curtailing the educational, æsthetic and scientific facilities provided".

Dr. F. J. North, of the National Museum of Wales, Cardiff, was elected president for the Conference in 1953, which will be held in York during June 22–26.

# IONIZING AND LUMINOUS EFFICIENCIES OF METEORS

By Dr. J. S. GREENHOW
and Dr. G. S. HAWKINS

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THE amount of ionization produced in the trail of a meteor of given visual brightness has been the subject of much discussion. Early workers[1] assumed that most of the kinetic energy of the meteor would be transferred to ionization; but in a recent review Herlofson[2] considered that the available evidence indicated that the fraction of the kinetic energy converted to ionization was only about 0·0001, and the fraction converted to visible radiation about 0·01. On this basis Herlofson estimated that the density of ionization produced by a meteor on the limit of naked-eye visibility (zenithal magnitude + 6) would be $10^{10}$ electrons per centimetre path, and by a very bright meteor (zenithal magnitude + 1) $10^{12}$ electrons per centimetre path. The preliminary combined radio echo and visual observations made by Prentice, Lovell and Banwell[3] in 1947 suggested that these estimates were approximately correct. The theoretical estimates depend on a knowledge of the transition probabilities in the collision of heavy ions, and in this respect data applicable to the conditions in meteor trails remain very inexact. Thus, any new information on the measured electron densities in trails of meteors of known visual magnitude is of particular interest. Recent work on the mechanism by which radio waves are scattered from the ionized trails has led to much more certain measurements of electron density. The purpose of the present communication is to discuss these measurements, which indicate that the actual luminous and ionizing efficiencies must be markedly different from those assumed by Herlofson.

The original measurements of electron density made by Prentice, Lovell and Banwell[3], and Lovell, Banwell and Clegg[4], were based on the theory of scattering developed by Lovell and Clegg[5]. This theory, which predicts that the amplitude of the echo is proportional to the linear electron density $\alpha$, assumes that the initial radius of a meteor trail is small compared with the wave-length, the electron density being sufficiently low so that the electrons in any cross-section scatter independently and in phase. Under these conditions, Herlofson[2] has shown that the echo duration to $1/e$ of the initial amplitude is independent of the electron density, and is given by

$$T = \lambda^2/16\pi^2 D, \qquad (1)$$

where $D$ is the diffusion coefficient for the ionized matter in the trail, and $\lambda$ the wave-length. Although this theory seemed to account satisfactorily for many of the observations, the existence of echoes of long duration has provided a major difficulty[6]. This difficulty has now been resolved, and recently[7,8] it has been shown that when the linear electron density appreciably exceeds $10^{12}$ electrons per centimetre, the model assumed by Lovell and Clegg breaks down, and the cylinder in the meteor trail inside which the electron density exceeds the critical value $N_c$ may be considered to behave as a total reflector for radio waves. Under these conditions, the amplitude of the radio echo increases only as the fourth root of the electron line density, $\alpha$, but the echo duration is now proportional to $\alpha$, being given by[7]

$$T = \alpha/4\pi D N_c. \qquad (2)$$

It is the overdense trails of this type which give rise to the meteor echoes of long duration. Evidently equation (2) provides an accurate method of determining $\alpha$, from measurements of the duration $T$, provided the diffusion coefficient $D$ can be determined. In the present work, $D$ has been determined from trails of low electron density which obey the Lovell–Clegg formula, and which decay exponentially according to (1). In order to obtain a satisfactory mean value of $D$, it is desirable to make measurements on a number of meteors ionizing in a narrow height-range, such as those in a homogeneous shower. The value of $D$ may then be substituted in equation (2), so that the electron line densities in meteor trails which give rise to long-enduring echoes may be obtained directly from the echo durations, independently of the parameters of the apparatus.

The most extensive observations relating the magnitudes of visual meteors to the appearance of the corresponding radio echoes have been made by Millman and McKinley[9], operating on a wave-length of 9·1 m. From a mean of several hundred visual meteor – radio echo correlations obtained during the Perseid meteor shower, these workers found the relationship between the echo duration and apparent meteor magnitude shown in Fig. 1. The measurements of luminosity are in terms of apparent visual magnitudes, and these may be corrected to zenithal magnitudes by reducing the ranges of the observed meteor trails to 100 km. The mean range of Millman and McKinley's[10] radio echo and visual meteor correlations was 155 km., giving a ratio of apparent intensity to zenithal intensity, for an average meteor, of 1 : 2·4. This corresponds very nearly to one stellar magnitude, and this correction has therefore been adopted. The revised experimental curve relating zenithal magnitude to duration of radio echo is shown as a broken line in Fig. 1.

The conversion of these echo durations to electron densities has been made from equation (2) by using the value of $D$ ($4 \times 10^4$ cm.$^2$/sec.), determined from the measurements on short-duration Perseid echoes as described above[7]. The final relation between linear electron density and zenithal magnitude is given in Fig. 2 (line $AB$). Extrapolation of $AB$ shows that a meteor of zenithal magnitude + 6 would produce

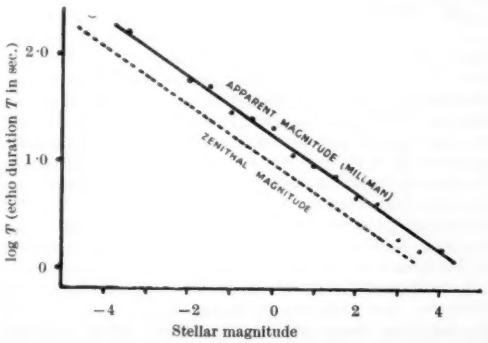


Fig. 1. Relation between meteor magnitudes and radio echo duration on a wave-length of 9·1 m.

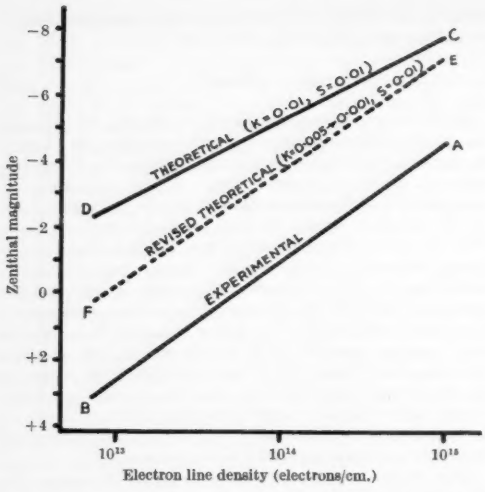


Fig. 2. Theoretical and experimental relations between the zenithal magnitudes and electron line densities of meteor trails

approximately $10^{12}$ electrons per centimetre path. This is one hundred times greater than Herlofson's estimate, and leads to a discrepancy of roughly 5 stellar magnitudes between the theoretical and experimental determinations of the electron line densities in meteor trails. The experimental points obtained by Prentice, Lovell and Banwell[3] for the relation between echo duration and magnitude during the 1947 Perseid shower agree with the relation found by Millman and McKinley in Fig. 1, when corrected for the difference in wave-length. The conversion to line density by these workers was made from the amplitude of the echo, on the assumption that the Lovell–Clegg formula applied to these trails. It is now evident that these trails were overdense, and that equation (2) should have been used for obtaining the electron density from the echo duration. The approximate agreement of their results with Herlofson's estimates was therefore fortuitous.

In view of the large disagreement between theory and experiment, it is of interest to search for any adjustments in the theory which could bring the results into agreement. The theoretical relationships between zenithal magnitude $M$ and electron line density $\alpha$, used by Herlofson, may be written as

$$M = 80{\cdot}4 - 2{\cdot}5\,(\log V^3 + \log K/S + \log \alpha), \quad (3)$$

where $V$ is the meteor velocity, $S$ is the probability that an evaporated meteor atom will produce an electron by collision with air molecules, and $K$ is the fraction of the kinetic energy of a meteor atom which is transformed into visible radiation. Originally, values of $S = K = 0{\cdot}01$ were adopted, producing the theoretical relation between zenith magnitude and electron line density given by $CD$ in Fig. 2. The discrepancy between the theoretical and experimental relations in Fig. 2 suggests that the values assumed by Herlofson for $S$ and $K$ are incorrect.

A more exact theoretical estimate of the luminous efficiency for meteors with a velocity of $6 \times 10^6$ cm./sec. has been made by Öpik, who obtained $K = 0{\cdot}001$ for faint visual meteors, and $K = 0{\cdot}005$ for very bright meteors (negative magnitudes). The luminous efficiency may also be estimated from the photographic observations by Whipple[11] and Jacchia[12], who obtained the following mean values from eleven bright Perseid meteors :

| Velocity (V cm./sec.) | Deceleration ($a$ cm./sec./sec.) | Zenithal magnitude ($M$) | Height (km.) |
|---|---|---|---|
| $6{\cdot}01 \times 10^6$ | $3{\cdot}1 \times 10^5$ | $-3{\cdot}0$ | $92 \pm 1{\cdot}3$ |

For a meteor, the rate of loss of kinetic energy $\mathrm{d}E/\mathrm{d}t$ is :

$$\frac{\mathrm{d}E}{\mathrm{d}t} = \tfrac{1}{2}\frac{\mathrm{d}m}{\mathrm{d}t}\,V^2 \text{ ergs/sec.} \quad (4)$$

The rate of loss of mass $\mathrm{d}m/\mathrm{d}t$ may be obtained from the deceleration of the meteor, $a$, and atmospheric density $\rho$ using Whipple's equation[11] :

$$\frac{\mathrm{d}m}{\mathrm{d}t} = 5 \times 10^{-13}\,\rho^3 a^{-2}\,V^7 \text{ gm./sec.} \quad (5)$$

For the rate of radiation of luminous energy $I$, by an object of stellar magnitude $M$, Öpik[13] gives the expression :

$$2{\cdot}5 \log I = 24{\cdot}6 - M. \quad (6)$$

At a height of 92 km. the atmospheric density is approximately $6 \times 10^{-9}$ gm./cm.$^3$, and when the observational data are inserted in equations (4), (5) and (6), the luminous efficiency $K = I \Big/ \frac{\mathrm{d}E}{\mathrm{d}t}$ is found to be 0·01. Because of the spread in the results, this value could be in error by a factor of 2, and it is therefore in fair agreement with the theoretical estimates of Öpik for bright meteors. The results of the photographic observations thus add weight to Öpik's estimates, and his values, when inserted in equation (2), produce the relation between magnitude and line density shown as $EF$ in Fig. 2, and the discrepancy between the theoretical and experimental curves is reduced.

The probability of ionization, $S$, may be estimated from the direct correlation of radio echoes with visual meteors. From $AB$ in Fig. 2 a Perseid meteor of magnitude $-3{\cdot}0$ produces $2{\cdot}4 \times 10^{21}$ electrons/sec. The rate of loss of mass for meteors of this brightness has already been determined from the photographic results, and, assuming the meteor to be composed of iron, corresponds to a release of $8 \times 10^{21}$ atoms/sec. This gives the probability of ionization as 0·3 ; but the spread in the original data will give values lying between 0·1 and 1·0. The remaining discrepancy between $EF$ and $AB$ is accounted for if $S = 0{\cdot}16$, which lies within the limits of this experimental estimate.

In conclusion, it seems that the best values for the luminous efficiency of Perseid meteors are 0·005 for bright meteors and 0·001 for faint meteors, and a more reasonable value for the probability of ionization is approximately 0·2. Meteors therefore produce more ionization than was originally estimated. Instead of the kinetic energy of a meteor being divided between heat, light and ionization, in the ratio $10^4 : 10^2 : 1$, the ratios are probably $10^4 : 10^2 : 10$ for bright meteors, and $10^4 : 10 : 10$ for faint meteors. These revised estimates imply that the visual magnitude corresponding to an echo of given characteristics is some 5 magnitudes fainter than that given by Herlofson. This means that the majority of radio echoes of short duration must arise from meteors

which are below the limits of naked eye visibility, and conversely that all visible meteors must produce radio echoes of long duration—a well-known observational effect. [June 20.


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# PHOSPHORYLATION OF XYLOSE BY EXTRACTS OF *PSEUDOMONAS HYDROPHILA*


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THE most generally accepted view of the pathway of xylose metabolism has been that of the splitting of the molecule into a $C_3$ and a $C_2$ portion[1]. The formation of xylonic acid from xylose by *Pseudomonas fluorescens* has been demonstrated by Lockwood and Nelson[2]. Lampen and Peterjohn[3] believe that xylose degradation occurs via a ribose phosphate, since only ribose-5-phosphate but not xylose-5-phosphate or arabinose-5-phosphate is metabolized by extracts of xylose-grown *Lactobacillus pentosus*.

That phosphorylation of xylose may take place in rat intestinal mucosa homogenates was recently suggested by the work of Hele[4]. No distinction was made, however, between the glucose- and the xylose-phosphorylating enzyme.

Evidence has now been obtained in these laboratories showing that xylose is phosphorylated at the expense of adenosine triphosphate by extracts of *Pseudomonas hydrophila* grown on a synthetic medium with xylose as the only source of carbon. In crude extracts, the initial rate of phosphorylation of xylose has been found to be much higher than that of glucose. Hexokinase activity has been successfully removed from the extract, leaving the xylose-phosphorylating enzyme intact in the final preparation. The latter enzyme has been shown to be specific for D-xylose among all the pentoses of known biological significance and will, therefore, be referred to as 'xylokinase'.

*Culture conditions and preparation of cell-free extracts.* *Pseudomonas hydrophila* (N.R.C. 492), originally isolated by Reed and Toner[5] from pike with 'red sore' disease, was grown on a synthetic medium composed of 20 gm. of D-xylose, 6 gm. diammonium hydrogen phosphate, 0·2 gm. potassium dihydrogen phosphate, and 0·25 gm. crystalline magnesium sulphate per litre of solution. Sugar and salts were sterilized separately and mixed aseptically before use. The *p*H of the medium after sterilization was 6·6, and this value dropped to 6·0 following a 24-hr. period of growth of the organism. The average yield of cells from 24-hr. shake cultures was 5·4 gm. per litre of culture medium.

The cells were washed three times with 0·85 per cent sodium chloride solution and were centrifuged off each time at 11,000 r.p.m. They were then ground in a mortar (mounted in an ice bath) for 30 min. in the presence of 3·5 times their wet weight of alumina[6] ('Alorco F-20', minus 80 grade) and sufficient saline to result in a smooth, batter-like paste. After grinding, more saline was added to give a 4 : 1 ratio of saline volume (ml.) to wet cell-weight (gm.). The suspension was then centrifuged at 9,000 r.p.m. for 10 min. and the upper, cell-free, opalescent layer was used for the subsequent experiments.

*Phosphorylation of xylose and glucose with adenosine triphosphate.* Phosphorylation of xylose and glucose was studied with the aid of the manometric technique of Colowick and Kalckar[7] and by the disappearance of acid-labile phosphate following phosphorylation with adenosine triphosphate. The rate of carbon dioxide output was measured in the conventional manner using a Warburg apparatus.

The experimental system in which evidence of xylose phosphorylation was obtained was composed of: sodium bicarbonate 0·023 *M*; magnesium chloride 0·0033 *M*; sodium fluoride 0·02 *M*; D-xylose 0·02 *M*; cell-free extract 1·0 ml. and adenosine triphosphate 0·0033 *M* (added at zero time from the side arm, dissolved in bicarbonate). The adenosine triphosphate used was the sodium salt assayed at 89 per cent purity. Xylose was freshly recrystallized from aqueous ethanol before use. Measurements were made at 27° C. in 95 per cent nitrogen + 5 per cent carbon dioxide in a total volume of 3·0 ml.

Control experiments which contained (*a*) no sugar and (*b*) no extract were always run. The resultant values from the controls were subtracted from the experimental figures to correct for the small adenosine triphosphatase activity of the extracts and the slight change in gas volume produced on tipping the adenosine triphosphate into the main compartment of the manometric vessels.

The results of phosphorylation by an extract from *Pseudomonas hydrophila* obtained following the fourth transfer of the organisms into fresh synthetic medium are given in Fig. 1. It was found that the initial rate of xylose phosphorylation was always greater than that of glucose, and that upon repeated transfers of the organisms into fresh medium the xylose-phosphorylating activity remained unchanged, whereas the hexokinase activity decreased slowly to a relatively constant value.

The disappearance of acid-labile phosphate resulting from phosphorylation was measured by the method of Fiske and Subbarow[8]. Assuming that the reaction product was an acid-stable phosphate, the determinations were carried out on filtrates obtained by treatment with 10 per cent trichloroacetic acid of the reaction mixtures following 40 min. of active phosphorylation under the same conditions used for the experiment presented in Fig. 1. Typical results following 7-min. hydrolysis in *N* hydrochloric acid are given in the accompanying table.

*Removal of hexokinase activity from extracts containing xylokinase.* Hexokinase activity was removed from the cell-free extracts of *P. hydrophila* by the

DETERMINATION OF ACID-LABILE PHOSPHATES

| Contents of reaction mixtures* | Acid-labile phosphorus in sample ($\gamma$) | Acid-labile phosphorus per vessel ($\nu$) | Phosphorus transferred to the sugars ($\gamma$) |
|---|---|---|---|
| Adenosine triphosphate (ATP) | 18·7 | 561 | — |
| Extract | 1·3 | 39 | — |
| Extract + ATP | 19·9 | 597 | — |
| Extract + ATP + D-xylose | 9·6 | 288 | 339 |
| Extract + ATP + D-glucose | 13·7 | 411 | 186 |

* This includes also sodium bicarbonate, magnesium chloride and sodium fluoride at the concentrations given in the text.

preparation of acetone-dried powders of these extracts without, however, affecting the activity of the xylokinase. Seven volumes of cold acetone were used[9], and the resulting precipitate was washed five times with cold acetone. The precipitate was then dried quickly on a Büchner funnel for a few minutes, followed by drying for an hour *in vacuo* over calcium chloride. The resulting fine, white powder was found to be stable in the refrigerator when kept in a desiccator over calcium chloride at 4° C.

When suspended in water, the acetone-dried powder was devoid of hexokinase activity but contained the xylokinase in undiminished activity (Fig. 2). This preparation did not phosphorylate D-ribose (0·02 *M*), D- or L-arabinose (0·02 *M*) or L-lyxose (0·02 *M*). The results using D-arabinose or L-lyxose are not shown in Fig. 2, since the total carbon dioxide output in 30 min. was not more than 2 c.mm. Iodoacetate (0·01 *M*) inhibited xylokinase activity most strongly, and it was found necessary to add magnesium ions in order to obtain maximum activity. The addition of 0·02 *M* glucose to the acetone-dried powder which phosphorylated xylose had no effect upon the xylokinase activity. The results shown in Fig. 2 are net effects, since the appropriate controls for each vessel without any added sugar have been subtracted. Xylokinase is therefore specific for the phosphorylation of xylose and appears to require free sulphydryl groups and magnesium ions for activity.

The Michaelis constant for xylokinase was determined using a quantity of 40 mgm. of acetone-dried powder per vessel in the presence of the required

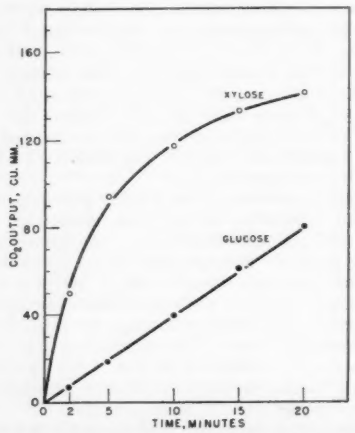


Fig. 1. Manometric estimation of the phosphorylation of D-xylose and D-glucose by a cell-free extract of *Pseudomonas hydrophila* in the presence of adenosine triphosphate

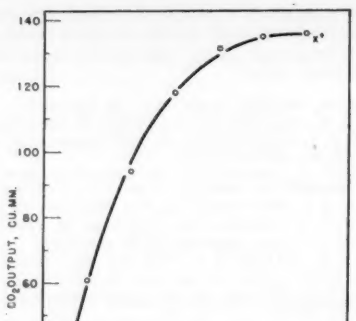


Fig. 2. Manometric estimation of xylokinase activity, the effects of a variety of sugars, iodoacetate and magnesium ions. Quantity of acetone-dried powder used (per vessel), 30 mgm. $X+$ = D-xylose; $G$ = D-glucose; $R$ = D-ribose; $A$ = L-arabinose; $X+I$ = D-xylose plus iodoacetate; $X^-$ = D-xylose without added magnesium ions

reactants (described above) and was found to be 0·0023 *M* (for xylose).

*Nature of the phosphorylation product.* The phosphate could be attached to the xylose molecule in one of several positions. On the basis of hydrolysis data given by Meagher and Hassid[10] and Levene and Raymond[11], it is established that: xylose-1-phosphate is 100 per cent hydrolysed when heated at 100° C. in *N* sulphuric acid for 10 min., whereas xylose-5-phosphate is only about 25 per cent hydrolysed when heated for 30 min. under the same conditions. Furthermore, the latter authors[11] were unsuccessful in their attempts to form a xylose-3-phosphate, since the ester always formed in the 5-position.

For purposes of the phosphate analyses reported here, heating was carried out at 100° C. in *N* hydrochloric acid for 7 min. and the reaction products kept in the form of trichloroacetic acid filtrates before the analyses were done. It would therefore appear likely that xylose-5-phosphate is the product of the xylokinase reaction. However, attempts to isolate and identify the end product and to elucidate the pathway of its metabolism are now in progress.

The technical assistance of Mr. Raymond Lapointe is gratefully acknowledged.

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# LETTERS TO THE EDITORS

*The Editors do not hold themselves responsible for opinions expressed by their correspondents. No notice is taken of anonymous communications*

## Electron Microscope Studies on Thin Sections of Human Erythrocytes

LITTLE is known about the inner structure of red blood cells. There are two main theories. One considers that the interior is a sponge-like network formed by structural proteins with the hæmoglobin in its intermicellar spaces. The other considers the erythrocyte as a balloon, containing free hæmoglobin in solution. Theoretical considerations, however[1,2], have shown that the blood pigment must be densely packed, and its degree of freedom is small, as follows from X-ray diffusion studies[3].

Direct observations by means of polarization[4,5] and especially electron microscopy[6-10] were successful for investigations of the membrane from 'ghosts' (hæmolysed cells) but failed to reveal the intact interior architecture. On one hand, no birefringence can be found there except in special cases[11,12], where hæmoglobin seems to exist in a *para*-crystalline or crystalline state; on the other hand, the non-hæmolysed erythrocyte is too thick to be examined under the electron microscope. The only way to study these cells was to obtain sections thin enough to be penetrated by the electron beam. But whereas sections of 0·4–0·2 μ commonly used in electron microscopy are transparent enough to study epithelial or mesenchymal cells, all the erythrocytes in the blood vessels of the same specimens remain homogeneously black or dark-grey. In a new series of experiments fresh blood clots fixed in 2 per cent osmic acid and embedded in 'Esterwax' were cut with a special microtome ('Rocking' Special Microtome, Cambridge Instrument Co., Ltd., Cambridge) at regular intervals without mechanical advance (4–5 movements for one tooth of the ratchet wheel), according to a technique described elsewhere[13].

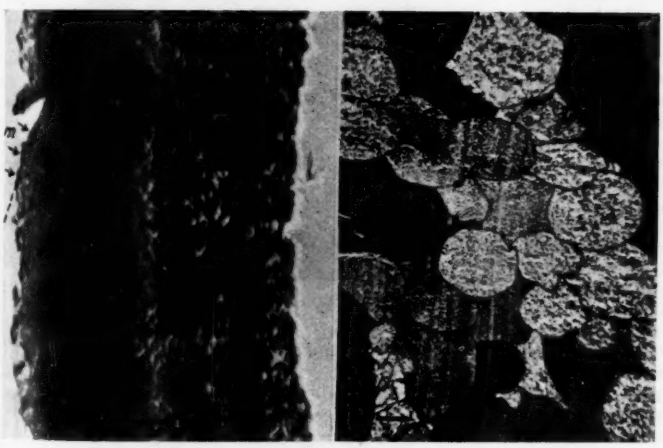
Though the 'Rocking' microtome is constructed for 0·2-μ thick sections only, after some attempts we were often able to get much thinner ones (0·1–0·025 μ, measured with latex-particles on shadow-cast grids). These specimens, the thinnest of which reached a hundredth of the normal red cell thickness only, were now transparent enough for our studies. Summarizing the observations, we can state that:

(1) *Without shadow-casting*, the osmium-fixed, non-hæmolysed human erythrocytes appear to be mostly homogeneous, densely packed without any visible structure. Some of them, however, show isolated denser irregularly dispersed spots. A very fine membrane of more definite osmiophilic character may be seen on the same fragments.

(2) *On shadow-cast sections*, the dense, homogeneous structure is of a granular (40 per cent), mostly filamentous (60 per cent) appearance (Fig. *a*). The filaments are 150–300 A. thick and show special orientation: on about half of the micrographs they are perpendicular, on one-tenth parallel, to knife incidence, on one-fifth they take an intermediate position, and the last fifth of the patterns show filamentous bundles crossed by others at certain angles (90°–150°). It has not been possible until now to find any constant relations between the direction of the filaments and the surface of the red cell. Though the high orderliness of the sub-microscopic structure is evident in the cut fragments, the architecture of the whole erythrocyte still remains to be elucidated, because ultra-thin sectioning generally breaks the red cell into fragments and it is almost impossible to say to which part the isolated fragment belongs, and at which level it has been cut. No findings, however, indicate entirely different zones in inner or outer parts of the red-blood cells, nor could isolated globular hæmoglobin molecules be distinguished, though they should become visible within these magnifications (38 A. of diameter, 75 A. of intermolecular distance after Ponder). When granules appeared, their diameter was about 200 A.; but it may be that they are, in fact, cross-sections of filaments representing a whole hæmoglobin lipoprotein complex.

(3) The membrane of the non-hæmolysed erythrocyte seems to be thinner than that of the ghosts, but its real thickness is very difficult to evaluate. The thinner the section, the less visible is the membrane. Nevertheless, it was not possible to show anything resembling the well-defined nuclear membrane of tissue cells. Measurements of the thinnest parts of the peripheral fragments show it to be 160 A. thick; on other areas it measures up to 320 A. No special structure, whether in the membrane itself or in the layers beneath, was visible. Sometimes the surface did not show any membrane at all.

(4) As soon as osmotic hæmolysis begins, the dense structure of the interior becomes clear and easily transparent. A very fine regular network appears and becomes coarse and irregular as the process proceeds (Fig. *b*). All the corpuscles are then delimited by a clearly visible sheet of 300–800 A. in thickness. The inner structure does not always lose its hæmoglobin with regularity. Some parts,



(*a*) (*b*)

(*a*) Thin section (about 0·05 μ) of a red cell fragment. *m*, Membrane. Filamentous structures parallel to knife incidence. Shadow cast with gold-palladium. (× 31,000). (*b*) Fine section of a blood clot. Partial hæmolysis (dist. water) with all the intermediate states from intact to almost empty cells. (× 3,800)

especially the thickened circumference, remain denser than others and disappear only when hæmolysis is complete. The erythrocyte is then entirely empty.

(5) From these observations, we can conclude that the intact red-blood cell has an extremely dense internal structure of granular or filamentous appearance, when fixed with osmic acid. There often exists a striking orderliness in its architecture. A spongy network and a well-defined membrane appear only when hæmolysis sets in. The completely hæmolysed erythrocyte is empty and balloon-like. Further details will be published elsewhere.

I am indebted to Dr. E. Ponder and Dr. D. G. Derwichian for an interesting discussion which encouraged me to continue the first investigations.

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Feb. 25.

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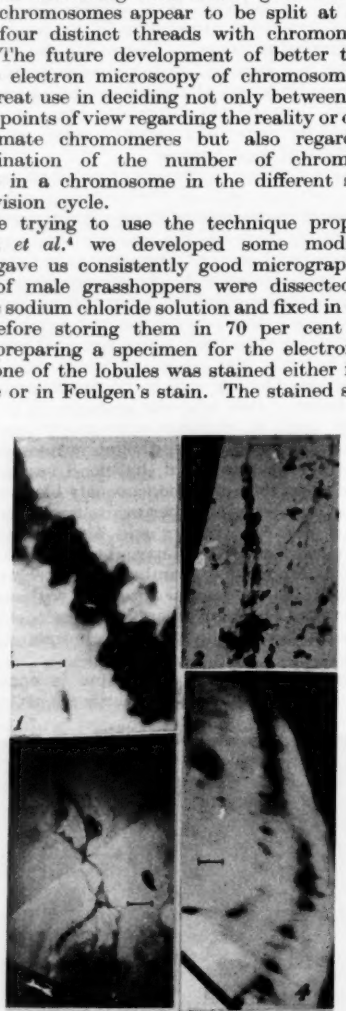
## Electron Microscopic Study of Grasshopper Chromosomes

The various methods used so far in preparing chromosomes for electron microscopy can broadly be classified into the following three categories: (1) cutting ultra-thin sections, (2) isolation of chromosomes, and (3) making squash preparations. Electron micrographs of the chromosomes of grasshoppers have been made by employing all these techniques. The material consisted of the spermatogonial cells and spermatocytes from the testes of adult male grasshoppers. The micrographs were taken by means of the new electron microscope installed in the Institute of Nuclear Physics, Calcutta, details of which have been published elsewhere[1]. Comparatively low magnifications were used purposely because we did not like the chromosomes to be magnified beyond recognition in our first attempt.

Fig. 1 is an electron micrograph from a sectioned preparation of the testes made after the method described by Pease and Baker[2]. The section has passed longitudinally through a portion of a compact, cylindrical, helically coiled chromosome probably of the metaphase or anaphase stage and the transverse disks are consequently interpreted as the gyres of the spiral. The coiled chromosome seems to possess a conspicuous coating of a substance much more transparent to the electron beams than the disks themselves. Fig. 2 is a similar micrograph of a pair of isolated chromosomes in the zygotene stage obtained by following the technique of isolation similar to that suggested by Claude and Potter[3]. Although they were extracted from the spermatocytes by a rather drastic procedure of crushing the cells with sand particles, the identity of the chromosomes in the micrograph is beyond any reasonable doubt. The comparatively large dark bodies on the threads are due to the adherent sand particles which could not be removed by washing. The individual chromosomes show distinct chromomeric structure in the portion which is comparatively free from sand particles. The chromomeres on the homologous chromosomes are more or less similar in size, thus indicating their homologous nature. The paired chromosomes appear to be split at one end, where four distinct threads with chromomeres are seen. The future development of better technique for the electron microscopy of chromosomes might be of great use in deciding not only between the conflicting points of view regarding the reality or otherwise of ultimate chromomeres but also regarding the determination of the number of chromonemata present in a chromosome in the different stages of the division cycle.

While trying to use the technique proposed by Schultz *et al.*[4] we developed some modifications which gave us consistently good micrographs. The testes of male grasshoppers were dissected out in isotonic sodium chloride solution and fixed in Carnoy's fluid before storing them in 70 per cent alcohol. When preparing a specimen for the electron microscope, one of the lobules was stained either in aceto-carmine or in Feulgen's stain. The stained specimen



(1) Longitudinal section of a metaphase or anaphase chromosome, × 8,000. (2) Zygotene bivalent. × 1,100. (3) Diplotene bivalent, × 3,750. (4) Zygotene bivalent, × 3,360. (5) Spermatogonial prophase thread, × 4,700

was transferred to 45 per cent acetic acid before making the squash, which was done on glass slides previously coated with a thin layer of collodion diluted 1 : 6. The cover-glass was at first gently pressed with the thumb, followed by a pressure with a *C*-clamp for the maximum stretching of the chromosomes. The slide with the cover-glass in position was placed on an ice block and, when sufficiently chilled, the cover-glass was prised off with a dissecting needle. This chilling helped in the retention of materials on the collodion film, which was then stripped off. In order to mount the desired part on the specimen grid, the stripped film was mounted on a clear slide with a film of water in between the film and the slide. The useful portion was selected under the optical microscope and separated with a sharp blade of a scalpel. The film was again floated on water and finally mounted on the specimen grid of the electron microscope.

Several electron micrographs were taken from squashes prepared by this method. Fig. 3 is a micrograph of a diplotene bivalent and it is clear that the structural details are more or less faithfully preserved. Fig. 4 represents a zygotene bivalent showing the chromomeric structures. A portion of the bivalent remains unpaired, and the structure of the chromomeres indicates the non-homologous nature of the unpaired portion. Fig. 5 perhaps represents an early prophase thread of spermatogonial divisional stages. The spiral structure seems to be the relic coiling, and an indication of longitudinal split in the chromosome is quite evident. The absence of differentiation into chromomere and interchromomere regions, in contrast with the prophase threads of meiosis, is a characteristic of the early mitotic chromosomes of the grasshoppers. Further work is in progress.

We wish to thank Prof. M. N. Saha and Dr. N. N. Das Gupta for their interest in the work, and to the Ministry of Education, Government of India, for financial assistance.

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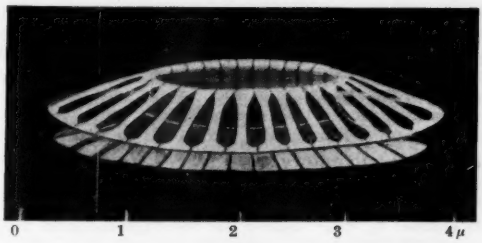
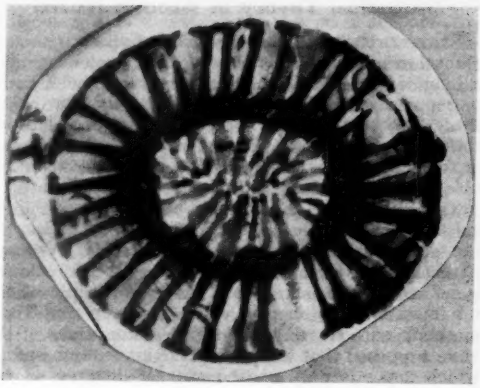
## Coccoliths of *Coccolithus huxleyi* seen in an Electron Microscope

The taxonomy of Coccolithophoridaceæ is based upon the morphology of the coccoliths. On account of the minute size of most of the coccoliths it has not been possible to obtain satisfactory pictures of them, even with the best optical equipment. This has caused confusion in the classification of coccolithophorids. It is illustrative that the most abundant and common species, *Pontosphæra huxleyi* Lohm., has been shown to include three taxonomical units with different coccoliths[1]. One is referred to the new genus *Gephyrocapsa* Kamptner, the others to *Coccolithus* Schwartz.




(*a*)



(*b*)

(*a*) Diagram of coccolith of *Coccolithus huxleyi*. (*b*) Coccolith seen from above. Photomicrograph by means of the electron microscope. (Photo. : T. Markali)

In collaboration with Mr. Toar Markali, of the Central Institute of Industrial Research, Oslo, we have been able to study the coccoliths of *Coccolithus* (*Pontosphæra*) *huxleyi* (Lohm.) Kamptner in an electron microscope. The coccoliths came from a unialgal culture of this species, started by the junior author during a stay on board weather ship *M.* off Norway last summer.

Fig. *a* shows a diagrammatic drawing of a coccolith, according to information obtained by means of the electron microscope and a Leitz phase-contrast microscope. Fig. *b* is a photomicrograph taken in the electron microscope of a coccolith seen from above. The thin lower disk can be seen through the central opening in the upper disk. The picture shows the following new details in the structure of the coccolith. (1) The upper disk consists of a large number of radial elements, which, on their inner end, also form a cylindrical connexion with the lower disk. (2) The lower disk does not have a central opening corresponding to that of the upper one. This last feature is of special taxonomic interest, since it is in contradiction to the definition of the tremalith, the coccolith type which includes the placoliths of *Coccolithus*.

A further study of a number of coccolithophorids by this method may be expected to necessitate a redefinition of the various types of coccoliths and possibly also a reclassification of Coccolithophoridaceæ.

A more detailed description of the coccoliths in *Coccolithus huxleyi* and *Syracosphæra carteræ* is being prepared by us in collaboration with K. Ringdal Gaarder and T. Markali for publication in *Nytt Magasin for Botanikk*.

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## Statistical Theory of Atomic Nuclei

Statistical methods have been applied to the explanation of the properties of atomic nuclei for quite a long time[1]. Hitherto, the energy of nuclei could be represented only in such a way that, according to the choice of the empirical parameters in the interaction energy of the nucleons, either for light nuclei or for heavy ones, the calculated values show noticeable discrepancies from the experimental values.

The purpose of the present communication is to calculate the binding energy of nuclei according to the statistical theory, assuming a scalar Yukawa potential for the nucleon interaction. The calculations are carried out on the general principle of the minimization of energy with the help of Ritz's method, without any arbitrary assumptions. We have supposed that the part of the interaction energy which depends only on the mutual distance of the nucleons is the same for the neutron–proton, neutron–neutron and proton–proton interaction and has the form:

$$J(r_{ik}) = -\gamma \frac{\exp(-r_{ik}/r_0)}{r_{ik}}, \qquad (1)$$

where $r_{ik}$ denotes the mutual distance of two nucleons, $r_0$ the Compton wave-length of the $\pi$-mesons and $\gamma$ an empirical constant. If for the mass of the $\pi$-mesons, $M_\pi$, the value of 285 electron masses is chosen—a value experimentally obtained by Powell and his collaborators[2]—one has

$$r_0 = \frac{h}{2\pi M_\pi c} = 1{,}355 \times 10^{-13} \text{ cm.}, \qquad (2)$$

where $h$ denotes the Planck constant and $c$ the velocity of light.

For the attractive energy between the nucleons, a pure exchange energy has been assumed. As further energy terms of the statistical nucleus, we have taken into account the kinetic zero-point Fermi energy, the kinetic inhomogeneity correction of Weizsäcker and further the Coulomb repulsive energy of protons as well as the Coulomb exchange interaction energy between protons, arising from the Coulomb interaction of protons[3]. All these energy terms are functions of the neutron density $\rho_n(r)$ and proton density $\rho_p(r)$, where $r$ is the distance from the centre of the nucleus.

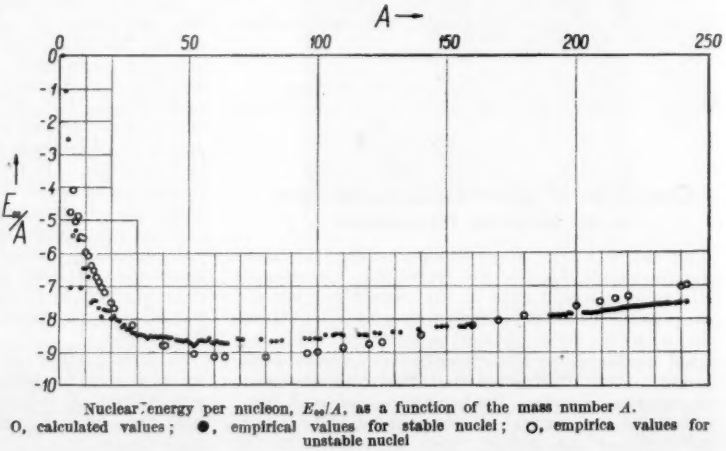
Our task is to determine the density distributions which make the total energy of the nuclei a minimum. The density distributions must fulfil the following conditions: first, the density distributions must be normalized with respect to the given number of neutrons and protons in the nucleus; secondly, at great distances from the nucleus, the density distributions must rapidly decrease to zero; and thirdly, for reasons of symmetry, the slope of the density distributions must vanish in the centre of the nucleus.

The first step of the Ritz method consists in setting up for the density distributions the following functions:

$$\rho_n(r) = \rho_{n0} \exp(-a^2r^2/r_0^2)$$
$$\rho_p(r) = \rho_{p0} \exp(-a^2r^2/r_0^2), \qquad (3)$$

where $a$ d notes a variational parameter and $\rho_{n0}$ and $\rho_{p0}$ are normalizing factors. For these one obtains, from the normalizing conditions, $\rho_{n0} = Na^3/(\pi^{3/2}r_0^3)$ and $\rho_{p0} = Za^3/(\pi^{3/2}r_0^3)$, where $N$ and $Z$ denote the number of neutrons and protons respectively. According to (3), in the first approximation the density distributions of neutrons and protons have been assumed to be equal, and a difference between the two density functions has been taken into account only inasmuch as the normalizing constants $\rho_{n0}$ and $\rho_{p0}$ are generally different because, except in the case of light stable nuclei, $N$ is not equal to $Z$. Inserting the density functions in the energy expression, the energy becomes a function of the variational parameter $a$, which can be determined from minimization of the energy.

In the whole theory the only empirical parameter is the constant $\gamma$ in (1). It will be shown that, by an adequate choice of this single parameter for the binding energy of nuclei, results can be obtained which are, from the lightest to the heaviest nuclei, in very good agreement with the experimental results. The discrepancies between the calculated values and the empirical ones are, except for very light nuclei, less than 7 per cent; for very light nuclei, the binding energy of which is not a monotonic function of the mass number, the statistical theory can give, of course, only a mean value of the strongly fluctuating empirical value, which is actually achieved by the statistical theory. In the accompanying diagram, for given mass numbers $A$, the calculated




Nuclear energy per nucleon, $E_\infty/A$, as a function of the mass number $A$.
○, calculated values; ●, empirical values for stable nuclei; ○, empirica values for unstable nuclei

values of the nuclear energies per nucleon, $E_{00}/A$, of the nuclei with the deepest energy are represented with the empirical ones[4].

The atomic numbers $Z$ of the nuclei with the highest energy for given mass numbers $A$ are also very satisfactorily obtained by means of the theory, the discrepancy between them and the empirical atomic numbers being throughout smaller than 8 per cent.

That the statistical theory developed here—applicable, according to its character, in the first place to nuclei of large mass number—offers such good results also for light nuclei is to be attributed to the fact that we have introduced two corrections. On one hand, we have eliminated from the statistical expression of the exchange interaction energy of equal nucleons the energy resulting from the self-exchange of the nucleons. On the other hand, a correction has been introduced for the kinetic energy whereby the statistical kinetic energy for the nucleus $^4$He and for lighter nuclei goes over into the exact wave-mechanical expression. By the use of these corrections, the statistical expression of the total energy of light nuclei is found to approximate closely to the wave-mechanical expression and gives a good mean value for the empirical results.

A detailed account of this work will be given in the *Acta Physica Hungarica*.

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## Cores of Terrestrial Planets

One feature of Prof. H. C. Urey's new theory[1] of the development of the planets is that it leads him to conclude on several grounds that the earth's central core has an iron composition. This conclusion is in conflict with Ramsey's proposal[2] that the density throughout the earth's deep interior, at least below a depth of 1,000 km., is essentially determined by pressure right through to the earth's centre rather than by change of chemical composition. The conclusion as stated is also in conflict, though to a less degree, with my proposals, which differ from Ramsey's through finding a balance of evidence[3] in favour of a separate chemical composition, such as nickel–iron with possibly some denser material, for the earth's *inner* core, but agree with Ramsey's in postulating a modified ultrabasic rock composition for the outer part of the core, that is, between depths of 2,900 km. and 4,980 km.—the region that I have referred to[4] as '$E$'; the latter postulate will be referred to as $\alpha$. On the further hypothesis, $\beta$ say, that the terrestrial planets have a common primitive composition, Ramsey's theory implies that neither Venus, Mars nor Mercury has an inner core, whereas my work favours the view that all three have inner cores.

The purpose of this communication is to show that evidence can be brought to bear to qualify a number of the arguments by which Urey infers an iron composition for the region $E$. At the same time, it is interesting that strong new support is found for the suggestion that the inner core is chemically distinct from the rest of the earth. Four main points will be considered, as follow:

(1) Urey appears to accept Elsasser's conclusion[5], based on Bridgman's experimental results and calculations of Feynman, Metropolis and Teller[6], using a Thomas–Fermi–Dirac model, that a silicate composition for the region $E$ "appears to be excluded". I have recently shown, however, that Elsasser's calculations are unsatisfactory in an important particular, a criticism which has been accepted by Elsasser (in a personal communication). My investigation leads me to the view that, on balance, the data of Bridgman and of Feynman, Metropolis and Teller tend slightly to favour a silicate composition for the region $E$, although they do not provide a crucial test. The details, which are intricate, are being published elsewhere.

(2) Urey considers that the mass and radius of Venus are so similar to those for the earth "that they can be made to fit any theory that accounts for the Earth". Actually, calculations by Jeffreys[7] on Venus show that, on the assumption $\beta$, the hypothesis that the region $E$ is chemically distinct from the mantle is untenable; the hypothesis yields 1 : 5·6 for the ratio of the mass of the central core of Venus to the total mass of Venus, as against a ratio of 1 : 4·1 for the earth. This discrepancy is in significant contrast to the measure of agreement obtained with observational data on Venus by Ramsey and myself on the opposite hypothesis $\alpha$.

(3) In respect of Mars, Urey directs attention to the discrepancy found by Ramsey in fitting this planet to the hypotheses $\alpha$ and $\beta$. But I have shown[2b] that if use is made of the earth model $B$[8], constructed from the hypothesis[9] that compressibility is a smooth function of pressure through the earth's deep interior, then $\alpha$ and $\beta$ fit the observed radius, mass and ellipticity of Mars within the standard errors of observation. I am repeating these calculations using revised observational data quoted by Urey, but unless the revision brings to light unexpected changes, Mars must be regarded as giving good support to $\alpha$ and $\beta$, the earth model $B$ having been constructed without any *ad hoc* adjustment to fit planetary data.

(4) Observational data on Mercury prior to 1950 were considered to be too imprecise to be used as a test of $\alpha$ and $\beta$. Rabe's recent calculations[10], based on the perturbations of Eros, give the mass of Mercury as 0·0543 times that of the earth, an increase of order 20 per cent from the previous estimate. Estimates of the value of Mercury's diameter are still very uncertain, and, taken along with Rabe's value of the mass, lead to estimates of the mean density ranging from 4·6 to 5·2 gm./cm.$^3$. Such values are incompatible with the possibility that Mercury may have the same mean density at zero pressure as other planets, and Urey interprets this as a further test against the presence of a silicate core in the earth.

If Rabe's revision is accepted, it is necessary to accept with fairly high probability that, in relation to the hypothesis $\beta$, Mercury is an exceptional planet in some important respect; only a considerable future upward revision of estimates of Mercury's diameter could affect this conclusion. But Mercury

may still be exceptional in this respect and yet at the same time compatible with α and β.

An obvious exceptional feature of Mercury is that it is the nearest planet to the sun, and it now turns the same face to the sun. According to radiometric measurements, the present temperature of the subsolar point at perihelion is 685° K., and the molecular weight of escaping molecules at this point would be about 70. This would permit the escape of some of the ingredients of an initial rocky mantle provided they could be volatilized sufficiently readily. Various mechanisms could be suggested for bringing about the temperature necessary for such volatilization; of these perhaps the most likely is that, earlier in the history of the solar system, the orbit of Mercury was much more eccentric than now and that Mercury was once much nearer the sun at perihelion. The suggestion then emerges that Mercury may well have lost not merely a normal atmosphere, but also an appreciable proportion of an initial rocky mantle, by volatilization and subsequent escape, and that Mercury was thus once a considerably larger planet.

On this suggestion, Mercury could still have the same primitive composition as the earth, Venus and Mars, and the region *E* of the earth could still be modified silicate rock. In fact, on this set of assumptions, it should be possible (subject, of course, to a number of uncertainties, including the uncertainty of the value of Mercury's diameter) to estimate the mass of the primitive Mercury; it is hoped to present this estimate in a later paper.

The suggestion here made may possibly bear some relation to the mechanism which Urey proposes, in his theory, for the fractionation of silicate and iron phases in various planets, taken in conjunction with the statement in his main thesis "that the primitive planets consisted of a grossly homogeneous mixture of silicate and iron phases". The statement quoted is consistent with hypothesis β and is consistent with ideas I have favoured. But the possible significance of Mercury's proximity to the sun leads me to question whether the present mean density of Mercury can properly be used for discriminating in favour of a predominance of the iron phase in the region *E* of the earth.

On the other hand, it would seem that the probability is now increased against that part of Ramsey's view which holds that the earth's inner core is essentially a second pressure modification of ultrabasic rock. On Ramsey's view, Mercury has no core, and Urey's criticism cannot be so readily met by assuming a substantial loss of material in the course of Mercury's evolution. A substantial loss would imply the presence of a modified-silicate core in the primitive Mercury, and, in the absence of a chemically distinct inner core, loss of the core would lower the mean density appreciably.

On the question of the difference between the views of Ramsey and myself, it may be stated that all available astronomical evidence now favours a distinct chemical composition for the earth's inner core. The observational data on all four of (*a*) the mass and diameter of Venus, (*b*) the mass and diameter of Mars, (*c*) the figure of Mars, and (*d*) the mass and diameter of Mercury, independently favour the presence of inner cores in these planets.

It has already been suggested by Jeffreys[11] that Urey's stimulating theory, which rests in large part on arguments from physical chemistry, may need some modifications in order to meet arguments from other sources; and it will be of interest to know how far hypothesis α can be fitted into Urey's theory of the origin of the planets without disturbing other important conclusions.

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## Radio-Frequency Radiation from Tycho Brahe's Supernova (A.D. 1572)

Since the discovery of localized sources of extra-terrestrial radio-frequency radiation in 1948 [1], surveys have been carried out over the whole sky[2,3], and the positions and intensities of about one hundred sources are now known. Although a few of these sources have been identified with extra-galactic nebulæ[3–5], it is generally considered that the majority must lie within the Galaxy with a distribution, and perhaps a density, similar to that of the common visual stars[6]. However, it has not yet been possible to associate the radio sources with any class of visual objects in the Galaxy, and in only one instance has an identification been made, namely, the identification of a source in Taurus with the Crab nebula[7]. As the Crab nebula is believed to be the remnant of the supernova of 1054, it is to be expected that the remnants of other supernovæ are also sources of radio radiation. The other supernovæ known to have occurred in the Galaxy are those of 1572 and 1604, but the published surveys show no radio source in either of these positions.

Recently, a detailed survey[8] has been made of that region of the sky which lies within the field of view of the 218-ft. paraboloid at the Jodrell Bank Experimental Station. The observations have been made at 158·5 Mc./s., and at this frequency the aerial has a beam-width of 2° between half-power points. In this survey a number of localized sources of radiation have been detected, several of which have not been reported previously. The co-ordinates of one of these sources agree closely with those of the supernova of 1572, as shown in Table 1, and in view of this agreement the radio source may be tentatively identified with the remnant of the supernova.

Table 1. Data on Radio Source and Supernova (1572) Epoch 1950

| | R.A. | Declination | Intensity* |
|---|---|---|---|
| Radio source | 00h. 21m. 49s. ±2m. | N. 64° 15′ ±35′ | $1·7 \times 10^{-24}$ W./sq.m./cps. ± 25 per cent |
| Supernova of 1572 (ref. 10) | 00h. 22m. 0·2s. | N. 63° 52′ 12″ | |

* The intensity given is twice that observed in one plane of polarzation.

The chief difficulty in observing this source lies in its proximity to the intense source Cassiopeia I (R.A. 23h. 21m. 12s., declination N. 58° 32′, Epoch 1950 [3]), and when it was first observed in 1951 there was some doubt as to whether it was genuine, or represented the reception of the nearby intense source in a side lobe of the aerial beam. This doubt has now been removed by means of a special interferometer which observed the two sources simultaneously, and showed that the radiation received from the source in the position of the supernova is incoherent with that received from Cassiopeia I. The proximity of this source to Cassiopeia I presumably explains why it was not reported in the survey made with an interferometer at 81 Mc./s. by Ryle, Smith and Elsmore[3].

Table 2 shows a comparison between the visual data available for the supernovæ of 1054 and 1572 and the intensities of the associated radio sources.

Table 2. Comparison of the Supernovæ of 1054 and 1572

| Supernova | Apparent visual magnitude at maximum brightness | Apparent integrated photographic magnitude of remnant | Intensity* of associated radio source (watts/sq. m./cps.) |
|---|---|---|---|
| A.D. 1054 | −6·5 to −7·0 (ref. 9) | +9 (ref. 10) | $19 \times 10^{-24}$† |
| A.D. 1572 | ∼ −4·0 | > +15 (ref. 11) | $1·7 \times 10^{-24}$ |

* The intensity is given for 158·5 Mc./s. and is twice that observed in one plane of polarization.
† This intensity is taken from the spectrum of the radio source given by Stanley and Slee (ref. 2).

No visible remnant of the supernova of 1572 has yet been observed, and the integrated photographic magnitude given in Table 2 represents the upper limit to the intensity, as estimated by Baade[11].

There is a difference of about 2·5 magnitudes between the intensities of the two radio sources, and this is equal to the difference between the apparent visual magnitudes reached by the supernovæ at maximum brightness. There is, however, a much greater difference of at least 6 magnitudes between the integrated photographic magnitudes of the remnants of the supernovæ. In view of the present lack of knowledge of the processes involved both in a supernova and in the emission of radio-frequency radiation from a localized source, it is not possible to offer any explanation of this discrepancy.

The discovery of a source in the position of the supernova (1572) supports the conclusion, originally based only on the observation of a source in the position of the Crab nebula[7], that the remnant of a supernova is a source of intense radio-frequency radiation. This phenomenon is of great interest since no satisfactory mechanism for the generation of the radiation has yet been proposed. Further evidence could be gained by a careful search for a radio source in the position of the supernova of 1604, which unfortunately lies outside the field of the 218-ft. paraboloid. The region has already been surveyed by Stanley and Slee[2] at 100 Mc./s., and no source in this position has been reported. However, their survey had a limit of detection of about $10^{-24}$ W./sq. m./cps., and the present results indicate that a source in the position of the supernova (1604) may have been overlooked.

The work has been carried out at the Jodrell Bank Experimental Station of the University of Manchester. We wish to thank Prof. Z. Kopal for directing our attention to the problem and Prof. A. C. B. Lovell for his interest in the investigation. One of us (R. H. B.) is indebted to Imperial Chemical Industries, Ltd., for a research fellowship, and the other (C. H.) to the Department of Scientific and Industrial Research for a maintenance grant.

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[1] Bolton, J. G., and Stanley, G. J., *Nature*, **161**, 312 (1948).
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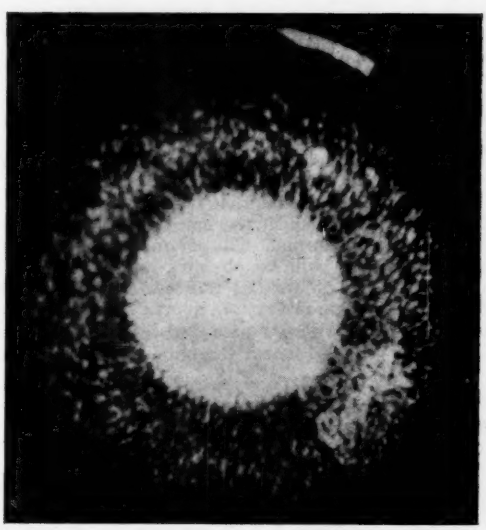
## Radio Echoes and Lightning

Observations are being made by 10-cm. radar at Salisbury, Southern Rhodesia, on distant and overhead storms and rain clouds.

On one occasion with a thunderstorm passing overhead, the vertically directed radar beam gave several unusual echoes which occurred simultaneously with lightning flashes. The echoes were recorded by a time-lapse camera used to photograph the P.P.I. screen. A copy of one of these photographs is reproduced herewith. It shows a circularly symmetrical precipitation echo, and a lightning echo appears as a curved streak of unusual brightness. In this particular case the height of the echo base above ground was 26,600 ft., the vertical depth of echo was 1,900 ft. and the echo duration 0·39 sec. The temperature at this level, from the early-morning *radio-sonde* sounding, was − 26½° C. Rotation of the P.P.I. scan was anticlockwise.

In other photographs obtained, but less suitable for reproduction, two echoes occurred concurrently and separated by varying intervals of height.



The echoes are being analysed in terms of the individual strokes comprising a discharge to ground, with special reference to the junction-streamer process described in a recent paper by Malan and Schonland[1].

It is suggested that the echoes originate from ionized portions of the cloud charge. A detailed paper is being prepared for publication.

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## Anomalous Properties in Quartz

Attempts to estimate quartz in certain New Zealand clays by the differential thermal method have revealed the occurrence of a variety with abnormal inversion properties.

The phenomenon was first observed[1] in clays occurring in the North Auckland peninsula as residual deposits formed by the weathering of dacite and rhyolite flows. These clays consist of 40–60 per cent of quartz, the balance being halloysite with minor amounts of felspars and accessory minerals. The quartz exists in two forms, one of which shows the normal $\alpha \rightleftharpoons \beta$ inversion at 573° C., while in the other form the inversion is more sluggish than usual and occurs at 555–560° C. The abnormal form is usually concentrated in the sizes below 75 microns.

Since the original observation in 1945, similar phenomena have been observed in decomposed rhyolite at Mount Somers, South Canterbury, and in well-weathered greywacke at Glen Massey, Newcastle Survey District. The associated clay mineral in these cases is kaolinite. In the North Auckland occurrences cristobalite and tridymite are frequently present.

When treated by the pyrosulphate fusion technique of Trostel and Wynne[2], the 0–10 micron fraction of clay from Parua Bay, Whangarei, yields pure quartz of the low-temperature (560° C.) inversion type. Measurements on this material show: (1) chemical composition, 99·3 per cent $SiO_2$; (2) X-ray diffraction pattern indistinguishable from normal quartz; (3) thermal expansion curve of the quartz type, but with a total expansion at 600° C. of 0·85 per cent, as against 1·10 per cent for normal quartz of the same particle-size; (4) the $\alpha \rightleftharpoons \beta$ inversion although more sluggish than normal, and the accompanying heat effect approximately half the normal value; (5) normal conversion to cristobalite above 1,470° C.

The evidence indicates that there exists a modification of quartz in which the mechanism of inversion differs from the normal. The ceramic implications of this observation will be obvious, and in particular the use of the differential thermal method for the quantitative estimation of quartz requires more critical consideration than it has hitherto received.

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Feb. 5.

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## Abnormal Thermal Behaviour of α-Quartz from some New Zealand Soils

In 1947, McDowall and Dunn[1] reported the differential thermal curves for free quartz in eight New Zealand clay deposits. They pointed out that the peaks of the α–β inversion were broader than those of quartz–alumina mixtures, and that in one case a small sharp peak at 573° C. was associated with a broader one at 555–560° C., resulting in an unusual double peak. The properties of these unusual forms of quartz are further described by McDowall and Vose[2].

In 1948, during an investigation of minerals in New Zealand soils, a number of soils were found to contain a form of quartz which, although shown by X-ray to be normal, well-organized α-quartz, failed to give the usual pronounced thermal effect due to $\alpha \rightleftharpoons \beta$ inversion in differential thermal analysis. The soils in which this form of quartz occurs include Mangatea silt loam from Katoa, Whirinoki clay loam from Hokianga, and Puhoi clay loam from Waiwera. These are weakly or moderately leached yellow-brown earths derived from sandstone or mudstone. They occur in locations some hundreds of miles apart and there is no suggestion at present that their parent material has a common origin. Their mineral colloids contain appreciable amounts of quartz, illite and montmorillonite. Quartz is highest in their silt fractions (between 2 and 20 microns equivalent diameter).

Characteristic behaviour is illustrated by the quartz from the silt fraction of the *B* horizon of the Mangatea silt loam. This silt appeared from X-ray diffraction to contain about 50 per cent of α-quartz, but its thermal pattern, judged by peak height and area, corresponded to less than 5 per cent of α-quartz. 53 per cent of free silica was separated from the silt by the pyrosulphate fusion method of Trostel and Wynne[3]. The separated material contained more than 99 per cent of $SiO_2$ and appeared from X-ray diffraction to consist almost entirely of α-quartz; but its thermal pattern corresponded to less than 10 per cent of α-quartz.

This form of quartz differs from the form of quartz in clay deposits described by McDowall and Vose[2]. The quartz from clay deposits has broadened peaks in the neighbourhood of 560° C., whereas the form from soils has a characteristic peak at 573° C., much smaller than that expected from the amount of α-quartz present. The thermal expansion of the quartz from clay is abnormal, whereas that of the soil quartz is normal. Cristobalite and tridymite are present in the quartz from some of the clay deposits, but none is detected in the soil quartz, although cristobalite has sometimes been reported in soils containing montmorillonite.

Berkelhamer[4] has stated that chalcedony registers a perfect quartz X-ray pattern but gives a reaction at the $\alpha \rightleftharpoons \beta$ inversion point equal in magnitude to that produced by approximately 1–4 per cent of quartz. This result is confirmed with New Zealand samples of chalcedony.

Optical examination of the silica residue of Mangatea silt loam was made by Mr. J. J. Reed, Geological Survey, New Zealand Department of Scientific and Industrial Research, who found that the sample contained a small amount of normal quartz, but consisted mainly of glassy isotropic material of refractive index 1·50, which is lower than that of chalcedony (1·537), the latter being

slightly lower than that of quartz (1·5442 and 1·5532).

It is possible that the small reactions at the inversion point of both chalcedony and the glassy material described are due to the presence of some normal quartz. It also seems that chalcedony may be in some way intermediate between normal quartz and the glassy material.

The evidence of the quartz from clay deposits shows that it is possible for a thermal effect related to the $\alpha \rightleftharpoons \beta$ inversion to occur at a lower temperature and more sluggishly than the normal change. Without further evidence it is not possible to determine if the behaviour of the quartz from soil and chalcedony is related or a separate phenomenon.

Whatever the mechanisms of the thermal effects, it is certain that the occurrence of the form of α-quartz described above would cause errors in any quantitative estimation of soil quartz based solely on the differential thermal method.

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March 14.

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## Twin Flames

Since Wolfhard's spectroscopic investigations of the reactions in a widened combustion zone at reduced pressures[1], the appearance and disappearance of a variety of chemical species in different regions of the luminous zone of hydrocarbon Bunsen flames have been demonstrated[2].

In the course of some studies on the effect of fuel additives on the laminar flame velocity of hydrocarbons burning in air at atmospheric pressure, we have found that in mixtures of fuels of widely differing reaction velocities (propane and diborane), within certain air–fuel limits, the reaction zone of a Bunsen flame separates into two distinct luminous regions

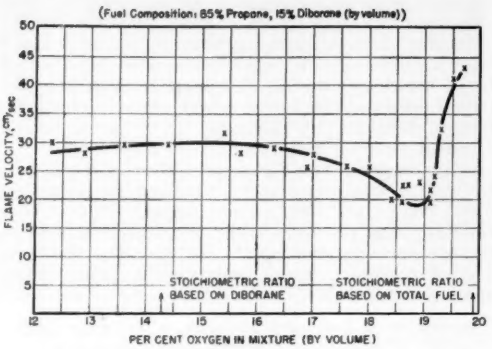
(Fuel Composition: 85% Propane, 15% Diborane (by volume))
FLAME VELOCITY, cm/sec
STOICHIOMETRIC RATIO BASED ON DIBORANE
STOICHIOMETRIC RATIO BASED ON TOTAL FUEL
PER CENT OXYGEN IN MIXTURE (BY VOLUME)

Fig. 2. Flame velocity of propane–diborane mixtures in air

(Figs. 1*A*, *B*, *C*). In this twin flame, the first luminous zone is believed to be due to the oxidation of diborane, the second to the oxidation of the hydrocarbon. As the air–fuel ratio is decreased, the diborane oxidation continues in a well-defined reaction front, and the hydrocarbon reaction zone disappears gradually and changes into a diffusion flame (Figs. 1*D*, *E*). Careful manipulation of the flow system enables one to quench the hydrocarbon reaction while still retaining the primary zone of the diborane oxidation. A plot of flame velocities (determined by the Smith–Pickering method[3]) with varying oxygen content in the mixture exhibits two maxima, one near the stoichiometric air–fuel ratio based on the total fuel, the other near the stoichiometric air–fuel ratio based on $B_2H_6$–air, considering the hydrocarbon as non-reacting diluent (Fig. 2).

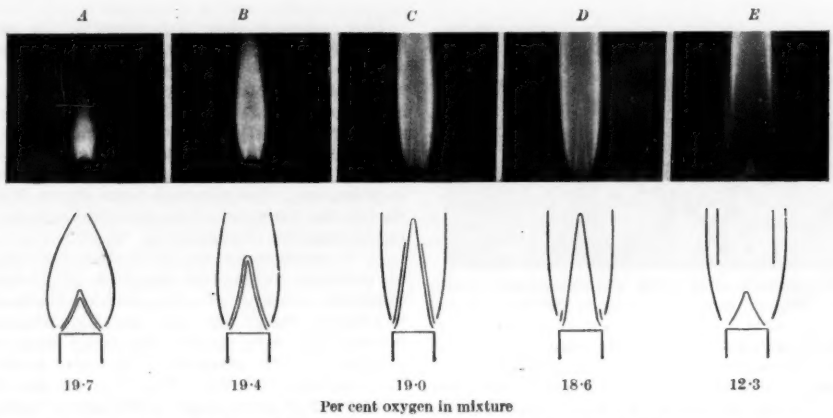


Fig. 1. Variation in twin flame fronts of diborane–propane–air mixtures with decreasing oxygen content

This work was supported by the Bureau of Ordnance, U.S. Navy, under Contract NOrd 7386.

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## Sedimentation of Halloysite

In the North Auckland peninsula of New Zealand there are extensive deposits of halloysitic clays formed by weathering of dacite. Attempts to determine the particle-size distribution of a well-crystallized sample from Matauri Bay, Whakarara Survey District, have revealed anomalous sedimentation behaviour.

A suspension having a concentration of 1 per cent by weight was prepared by tumbling for 16 hr. in 0·003 per cent sodium pyrophosphate solution, and the Andreasen pipette procedure was used to determine the concentration at 10, 5, 2 and 1 microns. The average of four determinations is given in the accompanying table.

Percentage of Halloysite remaining in Suspension after Settling

| Settling time (min.) | Nominal size (microns) | Percentage finer than size |
|---|---|---|
| 16 | 10 | 97·3 |
| 62 | 5 | 97·7 |
| 355 | 2 | 97·4 |
| 1,760 | 1 | 97·5 |

Fig. 1, which is an electron micrograph of the top of the suspension after three days settling, shows that there are many large particles remaining in suspension and that the size distribution determined by the pipette method has no relation to the true size-range. On prolonged standing, a clear layer develops at the surface and is followed by a zone of rapidly increasing concentration. Fig. 2 is an electron micrograph of the suspension 1 cm. below the surface, and at the top of this cloudy layer after two months standing. Although generally finer than after three days standing, there are numerous particles of one micron and larger.

Fig. 1. After standing for three days

Fig. 2. After standing for two months

It is suggested that the long rod-shaped particles form a loose lattice structure in the suspension and that this impedes the settling of the particles. The slow decay of this lattice on standing leads to the formation of a clear layer at the surface.

The electron micrographs were prepared by Mr. K. I. Williamson, of the Dominion Physical Laboratory, Department of Scientific and Industrial Research, New Zealand, and our thanks are due to the Director of that Laboratory for permission to reproduce them.

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## Decomposition of Organic Matter by Recoil Atoms from an Adjacent Phase

During experiments involving the irradiation of mixed powders of uranium oxide and graphite in the Harwell pile, BEPO, we found evidence of the decomposition of organic matter present in the graphite caused by fission processes occurring in the adjacent oxide phase.

'Ultra-fine' colloidal graphite powder from Messrs. Acheson, Ltd., was intimately mixed with an equal weight of uranium dioxide of 5 μ nominal particle-size. The mixture was heated in vacuum at 200° C. for 4 hr. in a silica vessel prior to irradiation. This vessel was connected by silica tubing to the Toepler pump outside the pile, so that gases evolved during irradiation could be collected, measured and analysed by the Blacet–Leighton technique[1]. The rate of evolution of gas could be determined by operating the pump at regular intervals and measuring the length of bubble in the calibrated delivery capillary.

The rate of evolution of gas showed immediate response to changes in pile power-level in a manner which suggested that thermal effects were not the cause. Moreover, the measured temperature under steady conditions at full power was only 75° C., while the rate of gas evolution at 200° C. prior to irradiation was a negligible fraction of that experienced at full power.

Similar experiments with graphite alone, uranium oxide alone, and with mixtures of zinc oxide and graphite gave very much smaller amounts of gas.

| Material | Thermal neutron dose ($n$ cm.$^{-2}$ × $10^{-17}$) | Gas evolved (mm.$^3$/gm. graphite) |
|---|---|---|
| ZnO + graphite | 16·5 | 0·5 |
| Graphite | 3·8 | 0·8 |
| $UO_2$ | 4·3 | 81 (per gm. of $UO_2$) |
| $UO_2$ + graphite | 3·8 | 1,332 |

This makes it clear that most of the gas evolved from the mixture of uranium oxide and graphite is dependent on the fission process in the uranium oxide and that the material being decomposed is not in the uranium oxide phase. Fission fragments and the atoms which they displace evidently pass into the adjacent graphite phase and cause decomposition of organic matter. The nature of this organic material is unknown; but thermal tests above 500° C. have shown the presence of appreciable organic impurity in the samples of graphite used.

It is interesting to note that for the mixture of uranium oxide and graphite, the whole of the available energy of the fission fragment (most of which would be lost in the uranium oxide phase) was only about 400 times the energy deposited in the graphite from pile neutron radiation alone, yet the evolution of gas from the mixture was more than 1,600 times that from the graphite alone. Fission fragments and the atoms which they displace are evidently much more efficient in causing the decomposition of organic matter than the atoms displaced by neutron scattering.

Our thanks are due to the Director, Atomic Energy Research Establishment, for permission to publish this communication.

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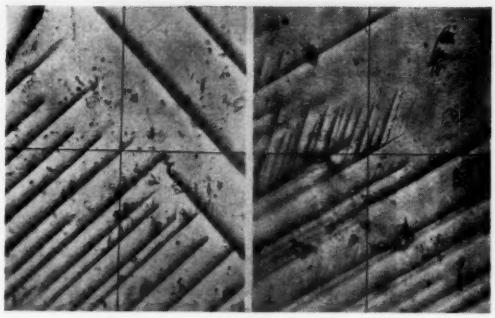
## Twinning Structure in Crystals of Tungsten Trioxide

A MICROSCOPIC examination of crystals of tungsten trioxide ($WO_3$) has revealed a type of twinning very similar to the domain patterns characteristic of the ferroelectric (tetragonal) phase of barium titanate ($BaTiO_3$). This similarity is significant in view of the reported ferroelectric behaviour of tungsten trioxide[1].

The crystals, examined under the polarizing microscope, were grown by sublimation of the vapours from a molten solution of tungsten trioxide dissolved in barium chloride, and contained in a platinum crucible. Their normal crystal habit was in the form of very thin plates which varied in their dimensions up to 5 mm. Most of them were almost transparent and ranged in colour through various shades of pale green. Apart from the truly single crystals, many of the specimens showed a highly twinned structure when viewed in a direction normal to the plate surface. In polarized light, a series of narrow, parallel bands, in general, extended diagonally across the crystal at an angle of approximately 45° to the edges. From the effects of optical extinction with respect to the directions of vibration of the polarized light, it was determined that the unit cell axes of one domain are perpendicular to those of its neighbour. These conclusions agree essentially with the observations of Ueda and Ichinokawa[2]. In addition to the fact that the cell axes, lying in the plane of the crystal, differ only slightly from each other in length, this appears to be a prerequisite for the formation of this domain pattern which is characteristic of the ferroelectric phase in general. In tetragonal barium titanate[3], the $a$ and $c$ axes of the unit cell differ by approximately 1 per cent only. In the analogous case of tungsten trioxide, the $a$ and $b$ axes, which lie in the plane of the crystal plates, have a difference of less than 3 per cent[4]; the much shorter $c$-axis is perpendicular to this plane. The symmetry of tungsten trioxide has been given as triclinic[4] because of the slight distortion of the interaxial angles from 90°. However, for purposes of discussion, the crystal may be described in terms of a pseudo-orthorhombic symmetry[2] with a twinning plane {110}.

The boundary between contiguous domains appears optically as a fine dark line. This may be due either to distorted unit cells at the junction, or to an actual mismatching between the respective lattices. The non-uniform optical extinction which often occurs at the boundaries would seem to indicate that these regions are in a highly strained state. This is especially obvious in the wedge-shaped domains, or those which have been formed by the convergence of their boundary planes within the crystal (Fig. 1). The banded domain pattern presumably results from the relief of internal strains developed during the growth of the crystal, the wedge domains merely representing an arrested or partial twin development.

On the larger specimens, twinning on a broader scale was commonly observed, whereby the crystal is divided into areas or distinct groups of line patterns oriented at right angles to each other. From the accompanying photographs it can be seen that the wedge domains exhibit a wide variation in width, and many of them have bifurcated ends. In Fig. 2 small branch domains can be seen developing from the larger ones at an approximate angle of 45°, that is, parallel to the crystal edges. It is significant that this 'feather' structure appears to develop on one side only of the boundary. All these peculiarities may be assumed to be the result of internal strain.



Domain structure of tungsten trioxide crystals. × 200. (1) Wedge domains showing the dark areas caused by internal strain. (2) Feather-like development of the domains

A more detailed explanation of some of the structural peculiarities of tungsten trioxide will be reported later.

I wish to thank the Director of the British Electrical and Allied Industries Research Association for permission to publish this communication.

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## Occurrence of Small-angle X-Ray Diffraction Maxima in some Artificial Cellulose Fibres

DIFFRACTION at small angles in cellulose fibres and rayon has been investigated by several workers[1]. Generally, a diffuse scattering increasing towards the primary beam has been observed on the equator of the fibre diagrams, with no distinct maxima characteristic of long spacings.

In fibres from highly oriented polyamides and from some other synthetic polymers, such as 'Terylene' and polythene, maxima at small angles have been observed on the meridian of the fibre diagram and have been related tentatively to a periodicity in the length and arrangement of the crystalline and non-crystalline regions in the direction of the fibre axis[2]. In well-oriented cellulose fibres no meridional maxima have been reported so far.

In an investigation on the small-angle scattering of various types of artificial cellulose fibres, exposed in the air-dry as well as in the water-swollen condition, we have found that some specimens in the water-wet state do show a distinct, though rather broad, equatorial maximum at small angles.

The exposures were made in a vacuum camera constructed by Backers in the Laboratory of Technical Physics of the Technical University, Delft, under the direction of Prof. H. B. Dorgelo and afterwards improved by Daams. This is essentially a three-slit arrangement with a metal wire for inter-

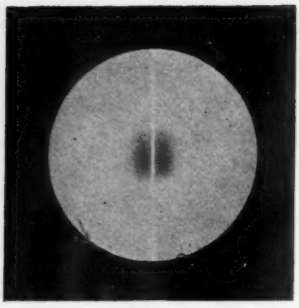

Fig. 1

ception of the primary beam[3]. The specimen-to-film distance is 77·6 mm. and the smallest observable diffraction angle 2 θ amounts to 0·0044 radians for copper radiation (corresponding to a Bragg spacing of more than 300 A.). In blank exposures no radiation whatever is detected on the film.

The fibres were exposed mounted parallel on a small rectangular wire frame, either in the air-dry condition or in the water-swollen state. In the latter case, the wire frame was enclosed in a small vessel provided with parallel windows made from very thin polymethylmethacrylate film and entirely filled with water. It was found to be essential to use radiation strictly monochromatized by reflexion from a crystal face.

Under these conditions, the photometer curves of the fibres exposed either dry or in the vessel filled with water are free from 'background' (that is, the blackening drops off to a zero value at some distance from the primary beam), and a blank exposure of the vessel with water does not produce any detectable blackening of the film in the small-angle region. (Exposure times were about 8 hr., using a powerful rotating-anode tube.) If nickel-filtered copper radiation is used, there is always a considerable background and, moreover, the small-angle maxima, if present, can scarcely be detected. This reveals the occurrence of rather large amounts of parasitic 'white' radiation of uncontrollable intensity even very near the primary beam. Under these conditions, blank exposures of the vessel also give rise to blackening of the film.

Fig. 1 is the monochromatic exposure of Fibre *G* in the wet state. In Figs. 2 and 3 are reproduced the photometer curves of monochromatic exposures of Fibre *G* (sample by courtesy of Du Pont de Nemours, Wilmington, Del.) and of 'Fortisan' (Celanese Corp.) in the air-dry state (*a*) and in the water-swollen state (*b*).

The positions of the maxima for the wet exposures correspond to Bragg spacings of 77 A. and 84 A., respectively. In the case of 'Fortisan' (Fig. 3), there is clearly an additional continuous small-angle scattering, increasing steeply towards the primary beam. In Fibre *G* (Fig. 2) there is no indication of a similar continuous scattering.

We wish to leave open for future discussion the interpretation of these maxima. At all events they indicate some rather pronounced lateral periodicity in the structure which is quite unexpected in artificial fibres.

No maxima have shown up in other rayons so far investigated; but work is in progress to extend the range of specimens.

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P. H. Hermans
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April 25.

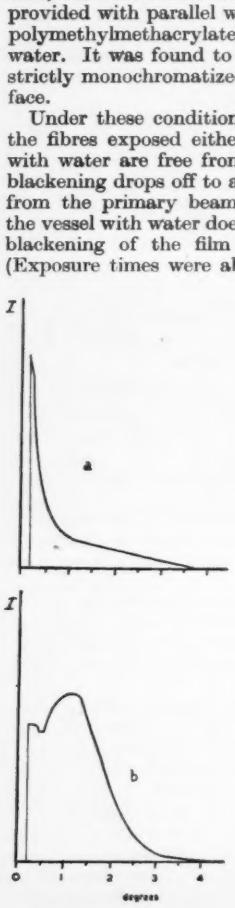


Fig. 2. Fibre *G*: (*a*) dry; (*b*) wet

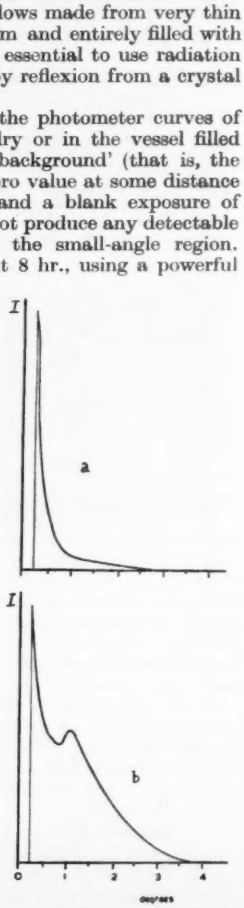


Fig. 3. 'Fortisan': (*a*) dry; (*b*) wet

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## Reaction of Vitamin A Aldehyde with Plasma Albumin

Cohn[1] has shown that carotene and vitamin A are concentrated in fraction III-O of plasma, which is a lipoprotein. It has been known for some time[2] that vitamin A can occur in water-soluble form in the urine of human beings in certain pathological conditions. In such cases protein is invariably present in the urine. It does not follow, however, that urine which contains protein can take up vitamin A when added to it. Adequate explanation of this phenomenon has not been forthcoming. The function of vitamin A in the visual cycle has been very elegantly demonstrated by Wald[3]. Recently, Morton[4] has shown that retinene, which is an important factor in the visual cycle, is vitamin A aldehyde, and he has also shown[5] how it can be prepared in the laboratory. It was therefore considered that attempts should be made to prepare a water-soluble compound of vitamin A with plasma protein and study its properties. The present preliminary communication summarizes the results obtained in this Institute.

*Plasma albumin solution.* This was prepared following Cohn's method[4], as follows. Bovine plasma was diluted with acetate buffer and brought to *p*H 5·9 at a temperature of − 3° to − 5° C. in a 'Thermos' flask, using a freezing mixture. To this was added, very slowly, a well-cooled solution of ethyl alcohol and acetate buffer (95 : 5) until the alcohol concentration of the mixture reached 40 per cent. Half an hour later, the mixture was filtered at a low temperature through Whatman filter paper No. 42. The clear filtrate, the protein content of which is entirely albumin[7], was diluted with phosphate buffer, *p*H 7·5, and an aliquot was dialysed in a rotary dialyser in a current of phosphate buffer (*p*H 7·5) in a cold room. Samples were taken at intervals and tested for the presence of ethyl alcohol by conversion to acetaldehyde, which was detected[8] by Schiff's reagent (max. absorption at 485 mμ). After dialysing for 36 hr., the albumin solution was found to be free from ethyl alcohol. After filtration and dilution, the absorption spectra of the albumin solution was taken (Fig. 1). It will be seen from the graph that the protein has an absorption peak at 280 mμ, which agrees with the value quoted in the literature[9].

*Vitamin A aldehyde.* Vitamin A acetate (1 million I.U./gm. in oil) was saponified with alcoholic potash, and vitamin A alcohol extracted with petroleum ether (40–60°). It was purified by chromatography, and vitamin A aldehyde prepared by Morton's method[5]. The absorption spectrum of the aldehyde was checked and found to have a peak at 369 mμ in petroleum ether. The solvent from an aliquot was removed *in vacuo*.

The residue was dissolved in ethyl alcohol and added to an aliquot of albumin solution. The mixture was shaken gently for about half an hour, and then dialysed in a rotary dialyser against phosphate buffer at *p*H 7·5, in the cold room. Tests for the presence of ethyl alcohol were carried out at intervals. After dialysing for 36 hr., the solution was found to be free from ethyl alcohol. It was then filtered and the absorption spectrum was taken after the necessary dilution. Two well-defined peaks, one at 280 mμ, characteristic of the protein used, and the other at 378 mμ due to the new chromophore, were found (Fig. 2).

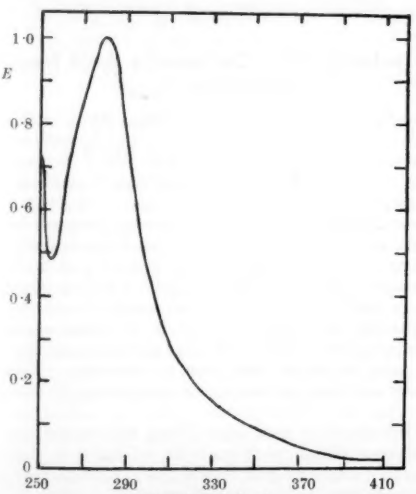


Fig. 1. Absorption spectra of plasma albumin in phosphate buffer (*p*H 7·5)

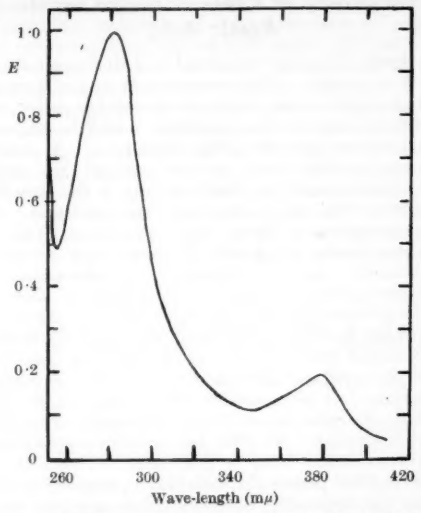


Fig. 2. Absorption spectra of condensation product of plasma albumin and vitamin A aldehyde in phosphate buffer

The solution of the albumin–vitamin A aldehyde complex, suitably diluted for spectrophotometric study, gave the following analysis for albumin (micro-Kjeldahl method) and aldehyde: (i) protein content, 0·968 gm./100 c.c. of solution; (ii) vitamin A aldehyde, $2·985 \times 10^{-5}$ gm./100 c.c. of solution; aldehyde content as percentage of protein content, 0·003.

In normal human plasma[10], 120–200 I.U. of vitamin A is associated with 6–8 gm. of protein; that is, 1 gm. of protein is associated with approximately 6 μgm. of vitamin A. In the condensation product of protein and vitamin A aldehyde, 100 gm. of protein is associated with 3,000 μgm. of vitamin A aldehyde, which is roughly equivalent to five times the concentration of vitamin A alcohol present in normal blood.

The sample of vitamin A acetate used was kindly supplied by Messrs. Hoffmann LaRoche and Co., Basle. We thank the Indian Council of Medical Research for financial support, and also Col. C. K. Lakshmanan, director of this Institute, for encouragement in the work.

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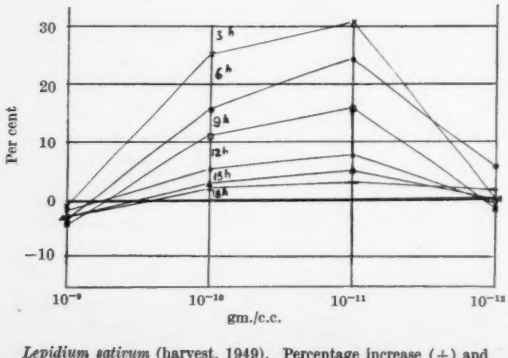
## Sensitivity of Cress Roots to Indole-Acetic Acid

In 1939, Thimann[1] recorded in a discussion on the growth of roots: "The amount of auxin normally in these roots is not far from the optimum for their growth, so that further addition could be expected to accelerate growth only slightly". A marked increase in the root growth induced by indole-acetic acid should be obtained only if the supply of the acid in the root is less than the optimum; thus distinct increases have been produced with decapitated roots depleted of their own source of indole-acetic acid[2]. However, experiments with *Lepidium sativum*[3], *Linum usitatissimum*[4] and *Artemisia absinthium*[5] have shown that it is possible to accelerate the root-growth of germinating seeds.

We found that the roots of germinating cress seeds have no constant growth-rate in spite of constant conditions. The measurements began 24 hr. after sowing. At intervals of 3 hr. the lengths of the roots were measured. At first the growth-rate increases to a maximum, then it decreases. The root of a cress seedling passes through three phases of growth: (1) at the beginning of germination a phase with a low growth-rate; (2) a phase of maximum growth-rate; (3) a phase of decreasing growth-rate. We were able to demonstrate by the determination of the indole-acetic acid content in roots of the second phase (5–6 mm. long) and of the third phase (20–25 mm. long) that the concentration of the acid in the short roots is about double that of the long roots. The amount of indole-acetic acid available to the roots determines the growth-rate. An acceleration of the growth-rate (about 15–20 per cent) was obtained with cress seedlings of the harvest 1944 and 1947, if the measurements were carried out in the third phase. The cress roots are sensitive to indole-acetic acid if their growth-rate is less than optimal.

The difference in duration of the first and second phases is evidently connected with the amount of indole-acetic acid in the seeds. We showed[6] that the amount of the acid contained in cress seeds of different years of harvest and of the same seedsman (H. Hild, Marbach, Germany) may be different: seeds of the year 1950 contain about ten times as much indole-acetic acid as seeds of the year 1947. The third phase is reached early with seeds of 1944 and 1947, late with seeds of 1949 and 1950.

The accompanying diagram shows the result of an experiment carried out with cress harvested in 1949,




*Lepidium sativum* (harvest, 1949). Percentage increase (+) and inhibition (−) of the growth of roots in comparison with control (o–o- line) at various concentrations of indole-acetic acid and various treatment times

in which the effect of immersing the roots in indole-acetic acid for different lengths of time was determined[7]. The greatest increase occurred after a short treatment. As the roots approach their phase of maximum growth-rate, their sensitivity to the acid decreases progressively. If the acid is added to roots in the maximum growth-phase there is no response.

The roots of the cress seedlings which are susceptible to indole-acetic acid must be used either during the first or the third phases, but not during the period of maximum growth-rate (second phase). Even then the concentration of indole-acetic acid must be low, $10^{-10}$ gm./c.c. or less. Thus before the test is applied, it is necessary to determine the growth-curve of the available seeds.

It is believed that the causes of the low growth-rates in the first and third phases are different. In the first phase, the supply of indole-acetic acid is insufficient, because there is a delay while the reserves in the seeds gradually become available. These processes of activation are very uncertain, and it is rather difficult to bring them under control. Therefore, the results show great variability. In addition, the errors involved in measuring small increments (1–3 mm.) are greater. A real deficiency of indole-acetic acid occurs during the third phase because the reserves in the seeds run low. The seedlings are in the dark, and the normal supply is not established. The response to indole-acetic acid is very uniform, and the measurement of the larger increases (17–22 mm.) can be done more exactly.

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## Isolation of a Carbamido Acid from Autolysed Yeast

Samples of baker's yeast that have undergone autolysis in presence of toluene or chloroform give an intense red colour reaction when boiled with diacetyl in hydrochloric acid, which is characteristic of compounds of the type[1] $—CH_2—NH—CO—NH_2$. Of the natural urea derivatives at present known, citrulline is the only one that gives a red carbamido diacetyl reaction; urea, itself, gives a yellow colour; allantoin and allantoic acid give varying shades of orange-pink, probably due to urea liberated under the conditions of the test; cyclic ureides do not react chromatically. Hence, it was assumed at first that the yeast reaction was due to citrulline, originally present as a unit, or arising from arginine by desimidation.

With the object of identifying the chromogen, the autolysate obtained from 6 lb. of baker's yeast was filtered, diluted and subjected to displacement chromatography on 'Zeo-Karb 215'. The progress of the operation was followed by means of the diacetyl reaction, and the carbamido-rich portion of

the effluent was collected and treated with copper carbonate. After recrystallization, a series of copper complexes was obtained, from which the most abundant fraction was selected for investigation. It differed completely in solubility and appearance from the known citrulline copper compounds. After removal of the copper, the carbamido derivative was isolated by recrystallization from water, and was obtained as an ash-free, almost colourless microcrystalline powder, the melting point of which remained constant at 238–239° decomp., after three recrystallizations. The yield was approximately 200 mgm., from 6 lb. of yeast. Analysis: C, 44·1; H, 7·8; N, 15·0 per cent, corresponding to the formula $C_7H_{14}O_4N_2$, which requires: C, 44·2; H, 7·4; N, 14·7 per cent.

*Properties.* The compound is very soluble in cold water, forming an acid solution. It is almost insoluble in absolute ethanol and other neutral organic solvents. Formaldehyde titration gives a value corresponding to one active $—NH_2$ group per $C_7$ unit.

*Function tests.* (1) Carbamido diacetyl reaction, deep red; (2) *para*-dimethylaminobenzaldehyde in *N*/1 sulphuric acid, bright yellow; (3) ninhydrin in hot, saturated boric acid, slow grey-violet (α-amino-acids react much more rapidly and vividly under the same conditions); (4) nitro-chromic test for primary and secondary alcohol groups[2], slow; (5) lactose test for short-chain primary amines and ethanolamine[3], negative; (6) Millon reaction for phenols, negative; (7) aldehyde tests for indoles, negative; (8) pentacyanoferrate test for amidines and guanidoxines[4], negative; (9) Sakaguchi reaction for substituted guanidines, negative.

The investigation was supported by a grant to one of us (W. A. B.) from the Medical Research Council of Ireland, and is being continued.

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## Role of Progesterone in the Mating Behaviour of the Ewe

It has been postulated[1-3] that a waning corpus luteum in the presence of a developing follicle is necessary to produce œstrus in the ewe. One attempt to test this hypothesis by treating the anœstrous ewe with 2–5 mgm. progesterone before gonadotrophin injection yielded negative results[1]. Pretreatment with 40–100 mgm. testosterone propionate has resulted in some 75 per cent incidence of œstrus following pregnant mare serum injection[4]; but rates of conception are low. This low conception is due to either suppression of ovulation or to faulty synchronization between ovulation and œstrus[3].

During December 1951, at which month ewes of British breed are in deep anœstrus in Australia, experiments were carried out on the Werribee State Research Farm near Melbourne, with the object of determining the role of progesterone in inducing mating behaviour. In the first trial, four groups, each of seven mature Suffolk ewes, were treated with 1,000 I.U. pregnant mare serum subcutaneously in saline, alone or in combination with 35 mgm. progesterone subcutaneously in oil. They were sacrificed at appropriate intervals after treatment and, in those ewes served, the Fallopian tubes were washed out in the search for ova. Treatments were as follows: (1) 1,000 I.U. pregnant mare serum alone; (2) 1,000 I.U. pregnant mare serum + 35 mgm. progesterone simultaneously; (3) 1,000 I.U. pregnant mare serum 24 hr. after 35 mgm. progesterone; (4) 1,000 I.U. pregnant mare serum 48 hr. after 35 mgm. progesterone. Results are shown in the accompanying table.

| Treatment No. | No. of ewes | No. of ewes ovulating | No. of ewes in œstrus | No. of ewes yielding fertile ova |
|---|---|---|---|---|
| 1 | 7 | 4 | – | – |
| 2 | 7 | 7 | – | – |
| 3 | 7 | 7 | – | – |
| 4 | 7 | 7 | 3 | 2 |

No significance is attached to three ewes failing to ovulate in group 1. All three had extremely small ovaries containing only rudimentary follicles. It is considered significant, particularly in view of subsequent work, that œstrus was observed in three ewes of group 4, but not in any other group. Œstrus and ovulation occurred 2, 3 and 5 days after injection of pregnant mare serum. It is also significant that fertile ova were recovered from two of the three ewes coming into œstrus. No ovum was recovered from the third ewe. None showed any evidence of a spontaneous corpus luteum which could have reacted with the injected gonadotrophin, so heat and ovulation are attributed to a progesterone–gonadotrophin synergism. The response obtained has approached physiological normality more closely than the previously reported testosterone–gonadotrophin synergism, and has yielded fertilized ova after a single injection of pregnant mare serum.

Two subsequent trials, in which progesterone was administered in 50 per cent ethanol both subcutaneously and intravenously up to 48 hr. before the injection of pregnant mare serum, yielded negative results, the ewes ovulating without œstrus. This indicates that pretreatment some time before an injection of pregnant mare serum, and slow absorption of the progesterone, are necessary for induction of œstrus; treatment earlier than 48 hr. before injection is indicated.

It is suggested that the action of progesterone is to develop receptors in organs such as the uterus, for example, these receptors responding to subsequent œstrogen stimulation resulting in œstrous behaviour. This view receives some support from the observation that tonic uterine contractions, normally present at œstrus, are absent at ovulations induced by gonadotrophin which are unaccompanied by œstrus[5]. Since œstrus with ovulation was observed as early as 48 hr. after administration of pregnant mare serum, and since progesterone did not appear to act like testosterone and inhibit or markedly delay ovulation, this would appear to preclude the suggestion[2] that progesterone acts simply by delaying ovulation.

Further work is planned for the next anœstrous season. Grateful acknowledgment is made to the staff of the Werribee State Research Farm, and in particular to Mr. Bruce McGregor, for their co-operation. Progesterone was kindly given by the

British Drug Houses, Ltd., and serum gonadotrophin by Boots Pure Drug Co., Ltd., to whom thanks are due.

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## Synthesis of Diphosphopyridine Nucleotide by Cell Nuclei isolated in Aqueous Media

It has recently been demonstrated that reasonably homogeneous preparations of cell nuclei can be isolated in good yield from rat or mouse liver[1]. By means of centrifugal fractionation of liver homogenates prepared in an aqueous medium (0·25 *M* sucrose — 0·0018 *M* calcium chloride), it has been possible to obtain 70–90 per cent of the nuclei with a minimum of cytological alteration in preparations containing by direct count less than 1 per cent of the intact cells of the tissue and less than 0·5 per cent of the free mitochondria of the homogenates.

The value of this method in cytochemical studies obviously depends on the permeability of the nuclear membrane. In this respect, Allfrey *et al.*[2,3] have contended that cell nuclei isolated in aqueous media are ill-adapted for studies of enzyme localization, primarily because extraction of water-soluble proteins is said to occur. These investigators have described a tedious method for the isolation of nuclei in organic solvents, utilizing desiccated tissue as the starting material. We are of opinion that it is unnecessary to resort to non-aqueous media.

Evidence for the integrity of nuclei isolated in aqueous media (other than their relatively high protein content[1]) has arisen from a study of the distribution in mouse liver homogenates of the enzyme catalysing the synthesis of diphosphopyridine nucleotide from nicotinamide mononucleotide and adenosine triphosphate. In a number of experiments, 69–101 per cent of the diphosphopyridine nucleotide-synthesizing activity of the homogenates was recovered in the nuclear fraction. Approximately 3 per cent of the original activity was found in the mitochondrial fraction, and the remainder was present in a fraction containing submicroscopic particles and the soluble material of the cytoplasm. The specific activity of the isolated nuclei (2·0–2·4 micromoles of diphosphopyridine nucleotide formed per hour per milligram of total nitrogen at 38°) was greater than that of the homogenates by a factor of 5–6. The higher recoveries of enzyme in the nuclear fraction (an average of 92 per cent in four consecutive experiments) were obtained when a step known to cause nuclear damage was eliminated from the fractionation procedure, and it seems entirely possible that the small amount of activity found under these conditions in the cytoplasmic fractions may have been the result of nuclear damage during the initial homogenization of the liver. When the isolated nuclei were disrupted by exposure to sonic oscillations[4] for 10 min. at 2°, approximately 85 per cent of the activity remained unsedimented after centrifugation for 30 min. at 130,000 times gravity.

The synthesis of diphosphopyridine nucleotide by liver cell nuclei is of interest for several reasons. The enzyme involved is a water-soluble protein that has been purified to a considerable extent[5]. Thus, at least in this one instance, the claim of Allfrey *et al.* with respect to the extraction of proteins from nuclei by aqueous media is not supported. Furthermore, so far as we are aware, the present finding comprises the first example of the clear-cut localization of an enzyme in isolated nuclei. Finally, since a number of diphosphopyridine nucleotide-linked dehydrogenases have been recovered largely in the cytoplasmic fractions[6], the synthesis of the coenzyme by isolated nuclei represents an example of an apparent biochemical interaction between nucleus and cytoplasm.

A more detailed description of the present work will be published elsewhere.

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## Behaviour of Fertilized Rabbit Eggs exposed to Glycerol and to Low Temperatures

Mammalian spermatozoa, red blood-cells and ovarian tissue suspended in glycerol-containing media have been cooled to, and maintained for long periods at — 79° C. or — 190° C., and have resumed functional activity when thawed and inseminated, transfused or grafted[1–4]. The present study of the reaction of fertilized rabbit eggs to glycerol and to low temperatures was undertaken to extend these researches to a different and more active type of cell, and one which has not hitherto been found to survive exposure to low temperatures[5,6].

Fertilized eggs were recovered from the Fallopian tubes of rabbits 18–25 hr. after injection of chorionic gonadotrophin and artificial insemination. In preliminary experiments they were transferred to homologous serum containing 15 per cent glycerol at + 20° C. Under these conditions the eggs shrank down within the zona pellucida, presumably because of the hypertonicity of the medium. At + 5° C. the shrinkage was greater. When transferred successively to 2·5, 3·75, 5 and 7·5 per cent glycerol in serum at + 20° C., they contracted and re-expanded during one hour at each stage, suggesting that glycerol was penetrating into the eggs. In the course of treatment with 10 and 15 per cent glycerol, however, they shrank irreversibly, and when incubated in 15 per cent glycerol for 18 hr. or cultivated in serum after removal of glycerol by gradual stages or by washing, they degenerated. By contrast, fertilized rabbit eggs treated in successive 10-min. stages with 2·5, 3·75, 5, 7·5, 10 and 15 per cent glycerol in serum at + 37° C. contracted only slightly and quickly re-expanded, suggesting that the ova were more permeable to glycerol at + 37° C. than at + 20° C. The glycerol was then removed at + 37° C. by

reversing these stages, and some of the eggs began to divide in 3·75 and 2·5 per cent glycerol and the remainder soon after transfer to serum. The majority continued development *in vitro* for a further 24–48 hr. and became morulæ, showing that brief exposure to glycerol at body temperature has not, apparently, any adverse effect on the egg. The necessity for treatment with warm glycerol is of particular interest, since most cells and tissues so far tested have tolerated glycerol well at room temperature, whereas the best results with bull spermatozoa were obtained[1] by prolonged soaking in glycerol at + 5° C.

Eggs treated with glycerol at + 37° C. were then cooled to, and kept at, different temperatures. The glycerol was removed after rewarming to + 37° C. and before cultivation. Of different batches supercooled in various ways to − 15° C., 75 per cent were viable after one hour, 67 per cent after one day, 60 per cent after two days and 69 per cent after three days at that temperature. By contrast, only 10–30 per cent of eggs were viable after an exposure of an hour to − 17° or − 20° C., or after four to seven days at − 15° C., when the medium had solidified. It seemed, therefore, that 15 per cent glycerol in serum at − 15° C. gave results little different from plain serum[7] at + 10° C. and was unpromising for long-term study of fertilized rabbit eggs.

Other batches of eggs in 10, 15 or 20 per cent glycerol in serum were cooled at different rates to − 79°, − 160° and − 190° C., and left for periods varying from 10 min. to two days before thawing at + 40° C. Immediately after thawing, all the eggs frozen rapidly by the method of Luyet[8,9] were ruptured, misshapen or degenerate. By contrast, a high proportion of eggs cooled relatively slowly by the methods used for sperm and ovarian tissue[1,4] were, on thawing, normal in appearance. After removal of glycerol, however, the majority degenerated. So far, out of a total of 556 eggs slowly cooled either to − 79° or to − 190° C., only six unicellular eggs, each from a different treatment group, have divided normally in culture. Three of them divided into two blastomeres, two reached the 4-celled stage, and one became 6-celled. Phase-contrast microscopy revealed no abnormalities of cleavage or in their structure.

This result is sufficient to show that exposure to low temperatures is not necessarily lethal to mammalian ova, even during the highly active and unstable phase between syngamy and segmentation. Further experimentation, especially on the rate of freezing and thawing and on the use of glycerol, should make it possible to increase greatly the rate of survival and elucidate further the processes involved in the freezing and thawing of living cells.

The help of Dr. A. S. Parkes is gratefully acknowledged.

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## Origins of the Volatile Fatty Acids in the Rumen

Members of the saturated fatty acid series $C_1$–$C_7$ are formed during the fermentation of wheaten hay or lucerne hay in the rumen of the sheep[1,2], and these acids, together with the methane and carbon dioxide also produced, account for a large part of the carbon of the digestible fraction of the fodder. Cellulose and hemicellulose form the bulk of this digestible material, and protein contributes to it to a lesser degree; it is therefore important to determine the nature of the products formed from each of these main components of the substrate. The fermentation of any particular compound may depend on the activities of a number of different organisms, and the detailed course of the degradation will present a difficult problem, involving, finally, a study of these organisms in pure culture. Its elucidation will, however, best be pursued in the light of knowledge of the products formed from the substance by the mixed culture of rumen organisms.

By means of the methods and techniques previously developed for the study of the fermentation of the natural fodders[3], we have examined the fatty acids produced *in vitro* from cellulose and hemicellulose when fermented alone, or together, or in the presence of wheaten hay. The products were compared with those formed from wheaten hay alone. We have also compared the products formed from a mixture of cellulose and hemicellulose with those produced from the same mixture in the presence of a small quantity of protein prepared from wheaten hay; and finally, we have fermented cellulose in the presence of various amounts of casein. The results of some of these experiments are presented in Tables 1 and 2.

It is clear that the fermentation of both cellulose and hemicellulose gave rise to approximately equal parts of acetic and propionic acids, together with a very small proportion of butyric acid, and that the presence of protein led to the formation of greater proportions of the latter acid. The formation of acetic and propionic acids from cellulose has already been described by Elsden[6] and by Marston[7]; but the production of these acids in approximately the

Table 1. Fermentation of Wheaten Hay and Some of its Separate Constituents

| Substrate | Composition of acid produced | | |
|---|---|---|---|
| | % Acetic | % Propionic | % Butyric (*e*) |
| Wheaten hay (*a*) | 54 | 26 | 20 |
| Cellulose (*b*) | 48 | 46 | 6 |
| Hemicellulose (*c*) | 46 | 45 | 9 |
| Cellulose, hemicellulose | 46 | 46 | 8 |
| Cellulose, hemicellulose protein (4%) (*d*) | 52 | 35 | 13 |

(*a*) Different samples of wheaten hay may show marked differences in the proportions of acids formed from them. (*b*) Cellulose prepared from wheaten hay by the method of Norman and Jenkins (ref. 4). (*c*) Hemicellulose prepared from wheaten hay by the method of McIlroy, Holmes and Mauger (ref. 5). (*d*) Protein prepared from wheaten hay. (*e*) Butyric acid includes any higher acids of the series which may have been present.

Table 2. Influence of Casein on Cellulose Fermentation

| Substrate | Composition of acid produced | | |
|---|---|---|---|
| | % Acetic | % Propionic | % Butyric |
| Cellulose (*a*) | 51 | 42 | 7 |
| Cellulose, casein (5%) | 47 | 31 | 22 |
| Cellulose, casein (10%) | 44 | 31 | 27 |
| Cellulose, casein (20%) | 45 | 25 | 30 |

(*a*) Finely ground filter paper.

same proportions from the two constitutionally different substrates, cellulose and hemicellulose, was unexpected, and is particularly interesting from the point of view of the intermediate products involved in each case. Confirmation of these findings with other samples of hemicellulose or with pure pentosans is needed.

Whether or not the degradation of separated cellulose or hemicellulose follows the same pathways as the degradation of the substances within the whole plant structure cannot finally be decided. It is possible that the course of fermentation of a particular substance may be altered by any considerable change in the nature of the substrate as a whole. It is therefore true that some doubt must always remain in the interpretation of these results. In this regard it may be mentioned that the acid formed from a mixture of cellulose (or hemicellulose) with wheaten hay was intermediate in composition between that formed from cellulose (or hemicellulose) on one hand, and that from wheaten hay on the other.

Since only a small proportion of butyric acid is produced from either cellulose or hemicellulose, some other origin for this acid in the fermentation of wheaten hay is implied. It has already been shown that part of the butyric acid in the rumen is synthesized from acetic acid[1], and it is possible that this accounts for the small quantities formed in the cellulose and hemicellulose fermentations. The present experiments suggest that another part of the butyric acid may be derived from the protein fraction of the fodder.

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March 25.

[1] Gray, F. V., Pilgrim, A. F., Rodda, H. J., and Weller, R. A., *Nature*, **167**, 954 (1951).
[2] Gray, F. V., Pilgrim, A. F., Rodda, H. J., and Weller, R. A., *J. Exp. Biol.* (in the press).
[3] Gray, F. V., Pilgrim, A. F., and Weller, R. A., *J. Exp. Biol.*, **28**, 74 (1951).
[4] Norman, A. G., and Jenkins, S. H., *Biochem. J.*, **27**, 818 (1933).
[5] McIlroy, R. J., Holmes, G. S., and Mauger, R. P., *J. Chem. Soc.*, 796 (1945).
[6] Elsden, S. R., *J. Exp. Biol.*, **22**, 55 (1945).
[7] Marston, H. R., *Biochem. J.*, **42**, 564 (1948).

## Stimulating Effect of Amino-Acids on the Survival at 37° C. of *Trypanosoma rhodesiense* in a Serum-free Synthetic Medium

Blood (whole, or as plasma, serum, erythrocytes or laked erythrocyte solution) is an essential component of culture media for many pathogenic Protozoa. The essential nutritive components in rabbit, ox, sheep, horse or pig serum required to maintain pathogenic African trypanosomes in culture at 37° C. in the trypanosoma form have not been investigated extensively since the discovery by Yorke, Adams and Murgatroyd[1] that *T. equiperdum*, *T. rhodesiense* and *T. gambiense* could be maintained under these conditions in an actively motile state and in undiminished numbers for 24 hr.

Suspensions of *T. rhodesiense* were prepared from infected mice and set up according to Yorke's basic technique. Marked variability in culture survival was traced to the serum content of the parasite inoculum. The importance of this factor is shown in experiments using washed parasites (Table 1).

Table 1

| Medium* | Serum concentration (v/v) | Survival time (hr.)† |
|---|---|---|
| *BR* | 6·3 per cent | >6 <23 |
| *BR* | 1·6 " | <1 |
| *BRG* | 0·1 " | 4 |

* For compositions of media, see later.
† Survival times refer to period during which parasites are actively motile and in undiminished numbers.

The more marked effect in the presence of glucose suggests coenzyme activity, and glucose dehydrogenase activity at 25° C. of washed *T. rhodesiense* suspensions (*M*/60,000 methylene blue, *M*/100 glucose in isotonic phosphate buffered Ringer solution *p*H 7·4; reaction in Thunberg tubes followed photometrically) is, in fact, stimulated by serum even in concentrations as low as 0·0004 per cent. Suspensions washed twice in *BR* gave reproducible survival times under standard conditions and were used throughout.

*Effect of glucose, trace metal salts and ten 'biologically essential' amino-acids on* T. rhodesiense *survival in sterile isotonic phosphate-Ringer (BR) p*H 7·4. The composition of these solutions was as follows: ('Pyrex'-distilled water and A.R. grade salts throughout; final concentrations in μgm./ml.).

*BR*: NaCl, 4,000; KCl, 100; $CaCl_2$, 100; $MgCl_2.6H_2O$, 25; $NaHCO_3$, 1,000; $KH_2PO_4$, 1,800; $Na_2HPO_4$ (anhydr.), 7,570.
*G*: Glucose, 2,000.
*M*: $FeCl_2.6H_2O$, 0·15; $CuSO_4.5H_2O$, 0·12; $MnSO_4.4H_2O$, 0·012; $NiSO_4$, 0·013; $CoSO_4.7H_2O$, 0·024; $ZnSO_4.7H_2O$, 22.
*A*: DL-Threonine, 126; L-valine, 63; L-leucine, 158; L-*iso*-leucine, 53; L-arginine HCl, 79; L-lysine HCl, 79; DL-methionine, 126; L-phenylalanine, 26; L-histidine, 26; L-tryptophane, 21; (total amino-acid concentration, 757 μgm./ml.).

All solutions throughout were sterile and the usual precautions were taken with heat-labile components.

Effects of these blocks of constituents on survival are shown in Table 2.

Table 2

| Medium block | No. of separate suspensions | No. of individual cultures | Survival time in undiminished numbers (hr.)* |
|---|---|---|---|
| *BR* | 2 | 6 | 0·5 |
| *BRG* | 9 | 11 | 1 |
| *BRGM* | 48 | 91 | 1 |
| *BRGMA* | 38 | 58 | 4·5 |

* Survival times refer to period during which parasites are actively motile and in undiminished numbers.

Of the 91 cultures with *BRGM*, 83 survived 1 hr. and 8 survived 1·5 hr., and of the 58 cultures with *BRGMA*, 19 survived 4·5 hr.; 9, 5 hr.; 9, 3·5 hr.; 7, 4 hr.; 7, 6 hr.; 4, 3 hr.; 2, 5·5 hr. and 1, 7 hr.

An effect quantitatively similar to that of the amino-acid mixture was produced by a vitamin-free casein hydrolysate (Ashe) at a level of 500 μgm./ml. Survival was found to be proportional to amino-acid concentration at levels down to 48 μgm./ml., and to casein hydrolysate concentration at levels down to 15 μgm./ml.

*Substances without effect on survival on addition to BRGMA. Added individually:* DL-cysteine, glutathione, L-cystine, L-tyrosine, L-serine, glycine, DL-aspartic acid, L-glutamic acid, creatine; ammonium chloride, urea; citrate, fumarate, malate, succinate; xanthine, hypoxanthine, uracil, thymine, guanine and guanidine.

*Added together or in a variety of combinations:* ascorbic acid, aneurin, riboflavin, biotin, pantothenate, pyridoxine, nicotinic acid, nicotinamide, inositol, choline, folic acid, *p*-aminobenzoic acid.

*Substances with significant effect (1–2 hr. prolongation) on survival on addition to BRGMA.* Adenine, adenosine, yeast nucleic acid (commercial), thymus nucleic acid (commercial), adenine and ribose and nicotinamide, adenosine and nicotinamide, adenosine and nicotinic acid.

Rabbit serum ultrafiltered through transparent cellulose (British Sidac, Ltd.; pore size 7–30 A.) and presumably protein-free (biuret negative) has a more marked but, compared with an equal volume of serum, incomplete ability to promote parasite survival (5 hr. with *BR, BRG, BRGM*, and about 8 hr. with *BRGMA*). A comparable effect is produced by 0·2 per cent 'Difco' bacto-peptone.

*Effect of gaseous environment.* All the above experiments were carried out in air. Carbon dioxide-free air, 100 per cent oxygen and 100 per cent nitrogen were found to be toxic for cultures in *BRGMA* containing water-soluble vitamins, adenine and ribose. Survival in this medium was enhanced by incorporation of 5 per cent carbon dioxide, and markedly enhanced by the mixture 5·6 per cent carbon dioxide, 7·8 per cent oxygen, 86·6 per cent nitrogen.

This work was carried out in the Department of Chemotherapy, Liverpool School of Tropical Medicine, during the tenure of a May and Baker Research Fellowship by one of us (J. W.) and of a Medical Research Council grant by the other (I. M. R.).

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[1] Yorke, W., Adams, A. R. D., and Murgatroyd, F., *Ann. Trop. Med. Parasit.*, **23**, 501 (1929).

## Chemical Composition of Mammalian Sperm

Mammalian sperm have been reported by various workers to contain no nucleoprotamine or nucleohistone extractable by the usual means (with water or neutral salt solutions)[1]. This has been confirmed in the case of the bull, man, dog, boar and ram, but basic protein and nucleic acid, having solubility properties quite different from the usual, have been extracted from the isolated heads of these cells.

A lipoprotein has also been extracted from the isolated heads of the above-mentioned sperm. In the case of bull sperm, this complex contains slightly more than 25 per cent lipid, which includes phospholipid and cholesterol. The lipoprotein of human sperm was found to contain only one component electrophoretically at *p*H 8·2.

The sperm heads can be fractionated, by a simple procedure, into three parts which make up almost all the total substance of the heads. The lipoprotein is obtained by extracting with a 0·14 *M* sodium chloride solution adjusted to *p*H 9 with sodium hydroxide, and the basic protein and nucleic acid by extracting with more strongly alkaline solutions. The lipoprotein is precipitated from solution at about *p*H 5·6, the basic protein in the region of *p*H 11 and the nucleic acid at about *p*H 2.

Details of this work will be published elsewhere.

This investigation was supported in part by a research grant, C-1327, from the National Cancer Institute, of the National Institutes of Health, U.S. Public Health Service.

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March 24.

[1] Mieschor, F., "Die Histochemischen und Physiologischen Arbeiten von F. Mieschor", 82 (Leipzig, 1897). Mathews, A., *Z. physiol. Chem.*, **23**, 399 (1897). Boshijan, G. M., *Trudy Lab. Izucheniyu Belka, Akad. Nauk. S.S.S.R., Otdelehie Himitcheskih Nauk*, No. 1, 49 (1940). Mirsky, A. E., and Pollister, A. W., *J. Gen. Physiol.*, **30**, 101 (1946). Thomas, L. E., and Mayer, D. T., *Science*, **110**, 393 (1949).

## Totem Poles and Blood Groups

In reviewing a book on totem poles in the Pacific coast region of British Columbia, Dr. G. H. S. Bushnell[1] accepts the suggestion that "the north-west coastal tribes may themselves have come over from Siberia within the preceding few centuries". This conclusion, which was formerly held, is negatived not only by the fact that the Eskimos have long occupied the whole of the Alaskan coast, but also by the blood groups of the Indians in question.

To test this very question, three hundred of the coastal Indians were blood-grouped many years ago[2]. Although much mixed with Europeans, they showed only 12·7 per cent *A*, and two *B* individuals, one of whom was Negroid. If they were a late wave from Siberia, they should have had a high frequency of *B*, like all the Mongoloid peoples of Asia. Ride and Furuhata afterwards tested 203 more Indians from the same areas with similar results. The high percentage of the *O* blood group (75–86 per cent) is thus quite incompatible with a late Mongoloid origin of the British Columbia Indian tribes. They must apparently be derived from an earlier stratum of Asiatic population, which is represented, at least in part, by some Tibetans and by certain remnant tribes on Formosa. This subject has also been discussed elsewhere[3].

R. Ruggles Gates
The Athenæum,
London, S.W.1.

[1] *Nature*, **168**, 725 (1952).
[2] Gates, R. R., and Darby, G. E., *J. Roy. Anthrop. Inst.*, **64**, 23 (1934).
[3] Gates, R. R., "Human Ancestry" (Harvard Press, 1948).

In quoting the suggestion to which Prof. Ruggles Gates takes exception, I did not mean to give the impression that I either accepted or denied it, since I did not feel competent to express an opinion about it.

The first objection, based on the distribution of the Eskimos, does not seem to me to exclude the possibility of a migration by sea. On the other hand, speaking as a layman in matters of genetics, I can only say that the evidence of blood groups seems conclusive, and I am grateful to Prof. Ruggles Gates for directing attention to it.

G. H. S. Bushnell

# FORTHCOMING EVENT

## Wednesday, September 3—Wednesday, September 10

BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE (at Queen's University, Belfast).—Annual Meeting.

**Wednesday, September 3**

At 8.30 p.m.—Prof. A. V. Hill, F.R.S.: "The Ethical Dilemma of Science" (Presidential Address).

**Thursday, September 4**

At 10 a.m.—Prof. A. M. Tyndall, F.R.S.: "Contributions to Experimental Physics from Britain" (Presidential Address, Section A).

At 10 a.m.—Prof. W. Wardlaw: "The Advancing Front of Chemistry" (Presidential Address, Section B).

At 10 a.m.—Prof. A. D. Peacock: "Some Problems of Parthenogenesis" (Presidential Address, Section D).

At 10 a.m.—Prof. Meirion Thomas, F.R.S.: "The Anatomy of Metabolism in Higher Plants; Metabolic Processes and Partial Reactions" (Presidential Address, Section K).

At 12 noon.—Prof. P. E. Vernon: "The Assessment of Personality" (Presidential Address, Section J).

At 12 noon.—Mr. J. Pimlott: "The History of Afforestation in Northern Ireland" (Chairman's Address, Section K*).

At 2 p.m.—Mr. J. A. S. Stendall: "Problems and Responsibilities" (Presidential Address, Conference of Delegates).

At 5.30 p.m.—Dr. D. W. Bronk, F.R.S.: British-American Association Lecture.

**Friday, September 5**

At 10 a.m.—Prof. D. T. Jack: "Full Employment in Retrospect" (Presidential Address Section F).

At 10 a.m.—Sir Ben Lockspeiser, F.R.S.: "Progress in Aeronautical Science and Engineering" (Presidential Address, Section G).

At 10 a.m.—Rev. Prof. E. O. James: "Archæology, Folk-lore and Sacred Tradition" (Presidential Address, Section H).

At 10 a.m.—Mr. A. L. Binns: "Education of Africans in East and Central Africa" (Presidential Address, Section L).

At 10 a.m.—Dr. N. C. Wright: "Britain's Food Supplies" (Presidential Address, Section M).

At 8 p.m.—Mr. A. C. Hartley: "Oil in Peace and War".

**Sunday, September 7**

At 8 p.m.—Prof. A. Macbeath: "A Plea for Heretics".

**Monday, September 8**

At 10 a.m.—Dr. J. E. Richey, F.R.S.: "Some Aspects of Geological Research and their Practical Application" (Presidential Address, Section C).

At 10 a.m.—Prof. R. O. Buchanan: "Aspects of Settlement in the Overseas Dominions" (Presidential Address, Section E.)

At 10 a.m.—Prof. R. C. Garry: "Nervous Control of the Movements of the Alimentary Canal" (Presidential Address, Section I).

At 8 p.m.—Sir William Slater: "Science and an Expanding Agriculture".

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# APPOINTMENTS VACANT

APPLICATIONS are invited for the following appointments on or before the dates mentioned:

AREA CHIEF CHEMIST at the Central and Research Laboratories, Nechells, Birmingham—The Industrial Relations Officer, West Midlands Gas Board, 6 Augustus Road, Birmingham 15 (September 6).

LECTURER IN ELECTRICAL ENGINEERING at the Rutherford College of Technology—The Director of Education, City Education Office, Northumberland Road, Newcastle-upon-Tyne 1 (September 6).

PHYSIOLOGIST (with a good honours degree in physiology and research experience, preferably involving the perfusion of isolated organs) for research on the bovine udder—The Secretary, National Institute for Research in Dairying, Shinfield, Reading, quoting Ref. 52/11 (September 6).

SENIOR LECTURER or LECTURER IN CROP PRODUCTION at the University College of the Gold Coast—The Secretary, Inter-University Council for Higher Education in the Colonies, 1 Gordon Square, London, W.C.1 (September 6).

ENGINEER-IN-CHARGE OF GENERAL AND CO-ORDINATION SECTION (with an honours degree in engineering or equivalent, and wide experience of large power station plant practice) (Ref. AE/279), and an ENGINEER-IN-CHARGE OF BOILER SECTION (with qualifications not below A.M.I.Mech.E. standard, and a wide knowledge of boiler plant design for large power stations) (Ref. AE/280); in the Generation (Plant Design) Sub-branch at Operational Headquarters in London—The Director of Establishments, British Electricity Authority, British Electricity House, Great Portland Street, London, W.1, quoting the appropriate Ref. No. (September 8).

SENIOR LECTURER IN METALLURGICAL ANALYSIS, to Honours B.Sc. (Metallurgy) standard, and a LECTURER IN CHEMISTRY—The Registrar, College of Technology, Suffolk Street, Birmingham 1 (September 8).

ASSISTANT LECTURER IN THE DEPARTMENT OF AGRICULTURE (Crop Husbandry)—The Registrar, University College of Wales, Aberystwyth (September 13).

ASSISTANT LECTURER or LECTURER IN CHEMISTRY (with special qualifications in inorganic or analytical chemistry)—The Registrar, The University, Sheffield (September 13).

VICE-PRINCIPAL AND HEAD OF THE UNIVERSITY DEPARTMENT, Fourah Bay College, Sierra Leone (University of Durham)—The Secretary, Advisory Committee on Colonial Colleges, 15 Victoria Street, London, S.W.1 (September 13).

FISHERIES SUPERINTENDENT AND OFFICER FOR THE PREVENTION OF POLLUTION—The Acting Clerk to the Wye River Board, 20 East Street, Hereford (September 15).

RESEARCH ASSISTANT (with a good honours degree and some research experience) IN THE LUMINESCENCE LABORATORY of the Department of Physics—The Registrar, The University, Edgbaston, Birmingham 15 (September 15).

DEMONSTRATOR IN GEOGRAPHY—The Secretary, The University, 38 North Bailey, Durham (September 20).

SENIOR RESEARCH OFFICER (Plant Pathologist) IN THE MICROBIOLOGY SECTION, Division of Plant Industry, Canberra, to undertake plant disease investigations and in particular to study fundamental aspects of host pathogen relationships and the mechanism of resistance to disease—The Chief Scientific Liaison Officer, Australian Scientific Liaison Office, Africa House, Kingsway, London, W.C.2, quoting No. 3948 (September 27).

ASSISTANT LECTURER IN THE PUBLIC HEALTH ENGINEERING DIVISION of the Department of Civil Engineering—The Head of the Department of Civil Engineering, Imperial College of Science and Technology, South Kensington, London, S.W.7 (September 29).

PHYSICAL CHEMIST or PHYSICIST for a research post under the Professor of Chemistry, to investigate the chemical composition of the stratosphere—The Secretary, The University, 38 North Bailey, Durham (September 30).

STATISTICIAN (a qualification in statistics, not necessarily medical, or in mathematics with experience of statistical work, is essential) to work on the problems of human reproductive performance in Aberdeen—Prof. Dugald Baird, Department of Midwifery, University of Aberdeen, Forresterhill, Aberdeen (October 1).

ASSISTANT or ASSOCIATE PROFESSOR OF ANATOMY (preferably with experience in gross anatomy or neuro-anatomy)—The Dean, Faculty of Medicine, Dalhousie University, Halifax, Nova Scotia, Canada.

ASSISTANT LECTURER IN CHEMISTRY, and a RESEARCH ASSISTANT IN METALLURGY—The Secretary, Northampton Polytechnic, St. John Street, London, E.C.1.

CHEMISTS AND PHYSICISTS (Senior Scientific Officer or Scientific Officer grade) for work on combustion processes in flames, at the Royal Aircraft Establishment, Farnborough—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.557/52A.

DESIGN ENGINEERS at the Atomic Energy Research Establishment, Harwell, for work on design of nuclear reactors and their components, to take part in design work either as individual designers or in charge of small teams engaged in development of nuclear power systems—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting C.512/52A.

EXPERIMENTAL OFFICER or ASSISTANT EXPERIMENTAL OFFICER (with chemical or biochemical experience) for enzyme research, and a SENIOR ASSISTANT (Scientific) with experience in chemistry or biochemistry—The Secretary, Rowett Research Institute, Bucksburn, Aberdeenshire.

GRADUATE to assist in work on nutritional and toxicological problems—Prof. A. C. Frazer, Department of Pharmacology, The University, Birmingham.

GRADUATE RESEARCH ASSISTANTS (3) IN THE DEPARTMENT OF CLINICAL CHEMISTRY, University of Edinburgh: for one post candidates should have a sound knowledge of zoology or comparative physiology and should be trained in histological techniques: for the other two posts training in biochemistry is required—Dr. C. P. Stewart, Clinical Laboratory, Royal Infirmary, Edinburgh.

HEAD OF THE ENGINEERING GEOLOGY BRANCH (Executive Engineer, Grade II) in the Scientific Services Division of the Snowy Mountains Hydro-Electric Authority, Australia—The Engineer-in-Charge, Snowy Mountains Hydro-Electric Authority, 18 George Street, London, W.1.

LECTURER, and RESEARCH ASSISTANTS (2), IN BIOLOGY (botany and zoology)—The Secretary, Royal Technical College, Glasgow.

PHYSICAL CHEMIST (with knowledge of the technique of electronics) to assist in the development of an installation for the dating of organic remains by the use of radioactive carbon—Dr. H. Godwin, School of Botany, or Dr. A. G. Maddock, Department of Chemistry, The University, Cambridge.

PHYSICAL CHEMIST (Principal Scientific Officer grade) at the Ministry of Supply London headquarters, for the initiation and progressing of research and development work on rubbers for Service purposes and advice to Service Departments on technical application of rubber—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.562/52A.

PHYSICISTS and PHYSICAL CHEMISTS (Experimental Officer grade) at a Ministry of Supply establishment at Aldermaston—PHYSICAL CHEMIST or PHYSICIST with interest, and preferably experience, in work on ceramic materials (Ref. F.550/52A), and a PHYSICIST with experience of X-ray diffraction (Ref. A. 219/52A)—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting the appropriate Ref. No.

RESEARCH WORKER with experience in X-ray crystallography, to assist with work concerned with the structures of nucleosides and nucleotides—Dr. W. Cochran, Cavendish Laboratory, Free School Lane, Cambridge.

SENIOR BIOCHEMIST (with an appropriate university science degree or the A.R.I.C., or an equivalent qualification, and wide experience of biochemical work, preferably in hospital laboratories)—The Secretary, Derby No. 1 Hospital Management Committee, Babington Buildings Babington Lane, Derby.

SENIOR EXPERIMENTAL OFFICER at Ministry of Supply London headquarters, for duties concerned with research and development of aircraft textile materials in all forms (fabrics, cordages, ropes, etc.) and involving technical consultations with industry and research organizations, placing and progressing of contracts and preparation of specifications—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting F.561/52A.

SENIOR PRINCIPAL SCIENTIFIC OFFICER at the Atomic Energy Research Establishment, Harwell, to take charge of mechanical engineering design work in nuclear reactor projects of considerable magnitude—The Ministry of Labour and National Service, Technical and Scientific Register (K), Almack House, 26 King Street, London, S.W.1, quoting C.498/52A.

UNIVERSITY GRADUATES IN ELECTRICAL ENGINEERING or in SCIENCE Subjects (which must include experimental physics) as ASSISTANT ENGINEERS (temporary) in the Department of Posts and Telegraphs, Ireland—The Engineer-in-Chief, Leitrim House, Dublin.